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THE TRIBE THRINCHINI OF THE SUBFAMILY PAMPHAGINAE, AND THE INTERRELATIONS OF THE ACRIDID SUBFAMILIES (ORTHOPTERA)

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WITH 73 FIGURES IN THE TEXT.

INTRODUCTION.

STÅL (1876, *Bih. Sven. Vet.-Akad. Handl.* **4** (5) : 19) established a group, THRINCHIDAE, for the genera *Thrinchus*, *Eremobia* and *Cuculligera*. Brunner von Wattenwyl (1882, *Prodr. eur. Orth.* : 176) adopted a tribe, EREMOBIDAE, for *Cuculligera*, *Eremobia* (with *Thrinchus* as its synonym) and *Glyphanus*. Saussure (1884, *Prodr. Oedipod.* : 61) separated "*stirps Thrincus*" from "*stirps Eremobia*," while in 1888 (*Addit. Prodr. Oedipod.* : 14) he called the same groups "legions" of Thrincites and Eremobiites. Jacobson (1902, in : Jacobson & Bianki, *Pryamokr. Lozhnoset. Ross. Imp.* : 170) adopted Saussure's division of OEDIPODIDAE into three subfamilies, Oedipodini, Thrinchini and Batrachotetrigini (= Eremobiini). Kirby (1910, *Syn. Cat. Orth.* **3** : 281, 283) used the subfamily names THRINCHINAE and BATRACHOTETRIGINAE, and this usage has been universally followed.

My original intention was to revise the Palaearctic genera commonly referred to BATRACHOTETRIGINAE, but a study of them has shown (as will be seen later), firstly, that the separation of THRINCHINAE from BATRACHOTETRIGINAE rests on a single purely formal and unstable character, and secondly, that BATRACHOTETRIGINAE cannot possibly be regarded as a subfamily equivalent to, and distinct from, PAMPHAGINAE. It proved necessary, therefore, to unite BATRACHOTETRIGINAE with THRINCHINAE to form a tribe within the subfamily PAMPHAGINAE. The name of the tribe should be Thrinchini, since it corresponds to the THRINCHIDAE of Stål (1876, *loc. cit.*) and is based on *Thrinchus* F.W. 1833, which is the oldest genus in the group.

The relation of the Thrinchini to the other PAMPHAGINAE could not be clarified until a review of the tribes that can be distinguished in PAMPHAGINAE had been made; this review (p. 19) has resulted in some modification of the current views and, it is hoped, will be of value in future studies of the subfamily. The next problem that arose naturally in the process of work, was the phylogenetic relationship of the subfamily PAMPHAGINAE, in the new broad sense, to other subfamilies, and a tentative scheme of the subfamily classification of ACRIDIDAE (p. 29) was the outcome. This scheme embodies some original ideas on the phylogeny of the Acridid subfamilies, substantially different from those recently advanced by Roberts (1941, *Proc. Acad. nat. Sci. Philadelphia* **93** : 201–246).

Before the present revision, there were 10 accepted Palaearctic genera referred to the Thrinchini (in the present sense), but 7 new genera had to be erected and one subgenus (*Eremopeza*) raised to generic rank, while one genus (*Haplotropis*, see p. 21) was removed, making a total of 17 valid genera. The number of species and subspecies tentatively regarded as valid is now 94, including two new species and four new subspecies, but a total of 123 published names had to be critically revised. It must be stressed that the primary aim of the paper was a generic revision and great care has been taken in classifying species by genera, but it was not possible to revise equally thoroughly the species and subspecies within each genus. In the case of some genera it proved possible to provide keys to species and subspecies, but these must be regarded as purely provisional, though the annotated lists compiled for each genus are believed to be complete. The lists include synonyms and the more important references, and special attention has been paid to establishing type localities.

COMPARATIVE MORPHOLOGY.

Although, as stated in the introduction, the Thrinchini are to be regarded as only a tribe of the subfamily PAMPHAGINAE, in the following discussion leading to that conclusion it is unavoidable to make comparisons between Thrinchini and the rest of PAMPHAGINAE. The latter include several groups which are more or less equivalent to Thrinchini, and are regarded as tribes; their scope and the relation to Thrinchini are discussed on p. 19.

LIFE FORM.—Most Thrinchini are relatively large, heavily built and sluggish insects, and the group includes the largest Palaearctic Acridid, *Tuarega insignis* (Lucas). As regards their habitus, three main life-forms are observed. One group of genera (e.g. *Glyphanus*, *Asiotmethis*, *Tmethis*, etc.) is characterised by a relatively broad, depressed body, and a tendency to lose organs of flight, typical of deserticolous ACRIDIDAE, that is, those living on the ground in an open country with scanty vegetation (Uvarov 1938, *Mém. Soc. Biogeogr.* **6** : 233). An offshoot of this group comprises more active insects, with excellent flying powers, such as *Utubius*, *Thrinchus* and *Strumiger*, which are more slenderly built. The third group includes insects with the body compressed laterally, a life-form characterising saxicolous ACRIDIDAE (Uvarov 1938, *loc. cit.* : 247), ecologically connected with more or less rocky ground. Here belong, for example, *Eremopeza* and *Iranotmethis*, while *Prionotropis* represents the maximum expression of the saxicolous life-form and does not differ in its habitus from the typical Pamphagini.

INTEGUMENTS.—Outer integuments in Thrinchini are characterised by a greater or lesser development of rugosities, tubercles and even short spines, particularly on the pronotum, pleurae and hind femora. The degree of rugosity

is to some extent a generic feature, but it is also subject to individual variation (see p. 35).

Coloration.—As a group, Thrinchini are characterised by the absence of a definite pattern, which is developed only in some members of the genus *Tmethis*. Otherwise, most Thrinchini are either uniformly coloured in various shades of dull-grey, brownish and other colours closely imitating soil surface, or bear irregularly scattered small spots. Bright colours are found only on the normally concealed parts, such as the inner side of the hind femur and tibia, sometimes the basal tergites of abdomen, and often the hind-wings. The latter organs are usually provided with a dark fascia, and the degree of its development and its shape supply useful generic characters, while the colour of the basal portion presents specific, or more often subspecific, variation. Another place where bright colours develop is the membrane between head and pronotum. Portschinsky (1886, *Hor. Soc. ent. Ross.* **20** : 116, pl. XII, fig. 5) has described and illustrated the coloration of the membrane in *Eremopeza gibbera*. In that species, when the head is forcibly bent forward, an orange membrane is revealed, bearing in the middle a pair of contiguous round violet spots, each with a white centre. It is not known whether the site of these ocellar spots marks the presence of some organ, and their biological significance remains unstudied. In *Asiotmethis heldreichi*, the neck membrane is uniformly purple-blue, without spots (Burr 1923, *Trans. ent. Soc. Lond.* **1923** : 117; Campbell 1923, *loc. cit.* : 133), and blue or blue-black is the usual colour in most other species of the group. Burr (1928, *Entom. Rec.* **40** : 125) has pointed out that the bright coloration of the membrane is found in other tribes of Pamphaginae as well.

Pilosity.—A feature of considerable taxonomic value consists in the degree of development of hairs on the body and legs. In some genera (*Asiotmethis*, *Tmethis*, *Filchnerella*, *Rhinotmethis*, *Glyphanus*, *Melanotmethis*, *Eremocharis*, *Tuarega* and *Utubius*) the sides of the body, particularly its lower edges, as well as hind femora and tibiae, bear abundant soft and rather long hairs; in others (*Pezotmethis*, *Iranotmethis*, *Eremopeza* and *Thrinchus*) there is only scanty pilosity on the body, and somewhat denser hairs between the spines of hind tibiae; while in *Atrichotmethis*, *Prionotropis* and *Strumiger*, there are no hairs even on the hind tibiae. Since such closely allied genera as *Thrinchus*, *Utubius* and *Strumiger*, differ widely in the degree of pilosity, this character has no phylogenetic meaning, but its practical value in separating genera is substantial, while its ecological significance may well deserve special study.

Antennae.—In all genera the antennae are simple, somewhat flattened, rarely (some *Eremocharis*) with a tendency to slight clavation. No difference in this respect exists between the Thrinchini and the majority of Pamphaginae, while the specialised ensiform antennae of some other Pamphaginae are unknown in Thrinchini.

Head.—*The profile of the head* in Thrinchini is always characterised by a broadly rounded transition between vertex and face. The face is approximately vertical, and either convex in its whole profile (*Prionotropis*, fig. 23), or, more often, with the upper portion roundly projecting forward and separated from the lower portion by a depression, or incision (figs. 17–21). The upper projection reaches a development bordering on monstrosity in *Rhinotmethis* (fig. 22), where it resembles the condition observed in certain Pamphagine genera (e.g. *Adephagus*, *Acinipe*).

The facial profile, as described above, depends on the structure of the *frontal ridge*. The ridge is always well developed in its upper section, but more or less depressed below the median ocellus. The ridge may be broad and scarcely

concave (*Tuarega*, fig. 15); or broad, with a shallow sulcus divided by a transverse septum just above the median ocellus (*Asiotmethis*, fig. 9; *Prionotropis*, fig. 10); or narrow with a deep continuous sulcus (*Tmethis*, fig. 14), etc. The genera with the more compressed frontal ridge do not differ in that respect from certain Pamphagine genera.

The *ocelli* are usually well developed, though in *Eremocharis* a tendency to their reduction is observed and the median ocellus may become obsolete. The reduction of ocelli in some apterous Pamphagine genera is a common phenomenon, but its obvious correlation with the loss of wings makes it almost useless taxonomically.

The position of the median ocellus in relation to the line connecting lower edges of compound eyes is a useful generic character. The lateral ocellus is always somewhat removed from the compound eye. This character is shared by all PAMPHAGINAE and PYRGOMORPHINAE, but its taxonomic value is doubtful, since the same relative position of the ocellus and compound eye is observed in many CATANTOPINAE and OEDIPODINAE.

The structure of the *vertex* in Thrinchini provides some of the best generic characters, if due attention is paid to the homology of its different parts, and irrelevant secondary features (tubercles, short ridges, etc.) are disregarded. The vertex of *Asiotmethis* is differentiated most, and it is convenient to discuss it first, since other types can be deduced from it (this is not meant, of course, phylogenetically).

The following parts of the vertex can be distinguished in *Asiotmethis* (figs. 1, 9):—

Vertex proper, a roughly hexagonal area between compound eyes, delimited laterally by raised carinulae, but open in front and behind; surface sloping forward, weakly concave, with irregular scattered tubercles and short carinulae (not shown in the diagram).

Fastigium of vertex (F), small, weakly concave area in front of the vertex, slightly more sloping forward than the latter, often (but not always) divided by a longitudinal carinula into two contiguous cells.

Preocellar foveola (P), elongate-trapezoidal, adjoining the antero-lateral margin of the fastigium and placed on a slightly lower level, but scarcely more sloping, and, therefore, almost fully visible from above.

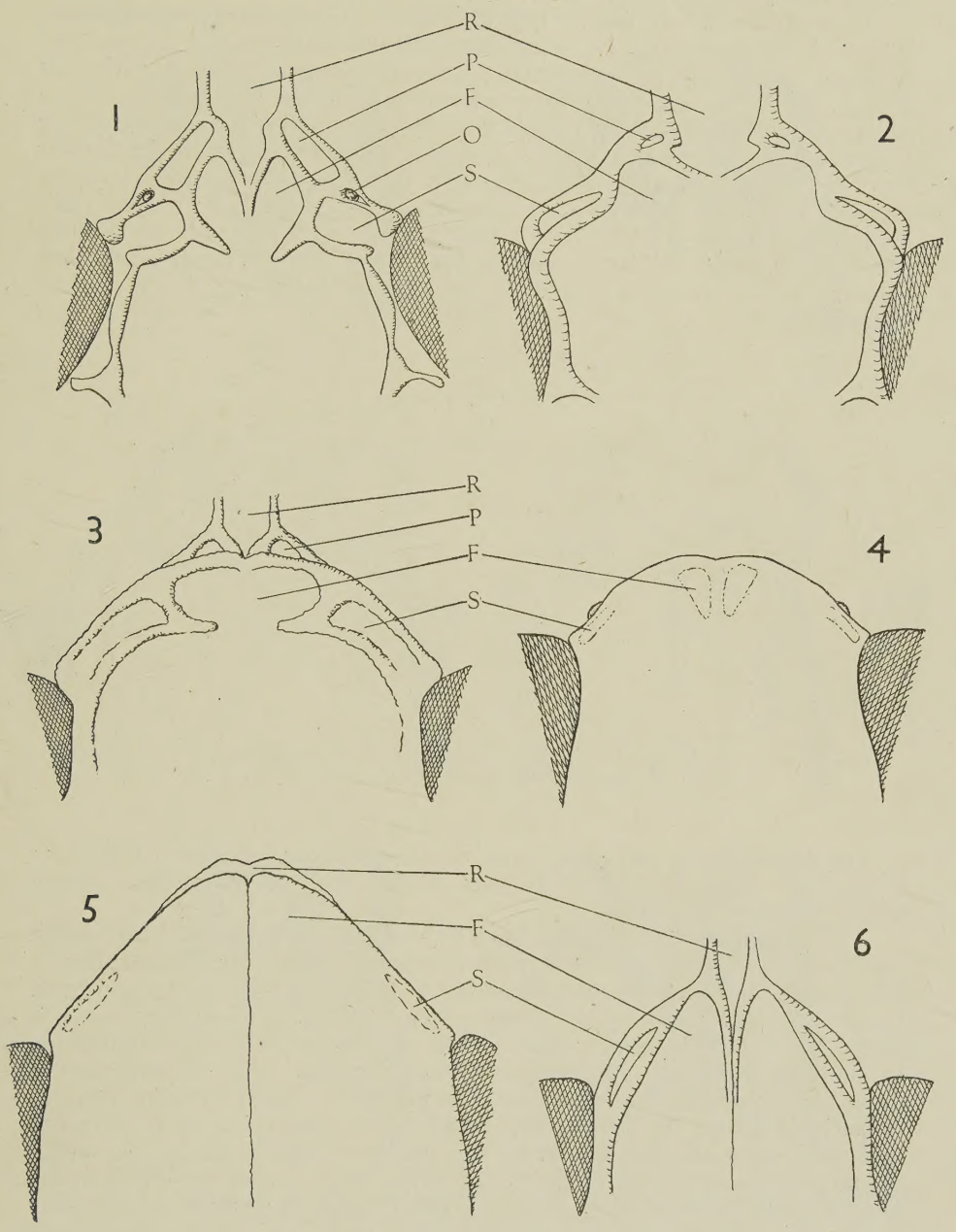
Supraocellar foveola (S), roughly rectangular, adjoining the postero-lateral margin of the fastigium, and placed at the same level.

Ocellar foveola (O), enclosing the lateral ocellus, is short, broadly trapezoidal, but placed on almost vertical slope and therefore scarcely visible from above.

Essentially the same general plan of vertex is found in *Pezotmethis* and *Iranotmethis*, while *Atrichotmethis* differs only in all the carinae being weakly developed, foveolae scarcely concave, and the vertex proper flat and broad.

A modification of the same type is seen in *Melanotmethis* (fig. 3). Here the fastigium becomes very broad and the supraocellar foveolae poorly defined; their lower (or external) margin is continuous with the anterior margin of the fastigium, and forms an edge, the sides of the fastigium being almost vertical, with the result that the preocellar foveolae (which are very irregular) are placed on a much lower level than the fastigium and almost concealed under its edge.

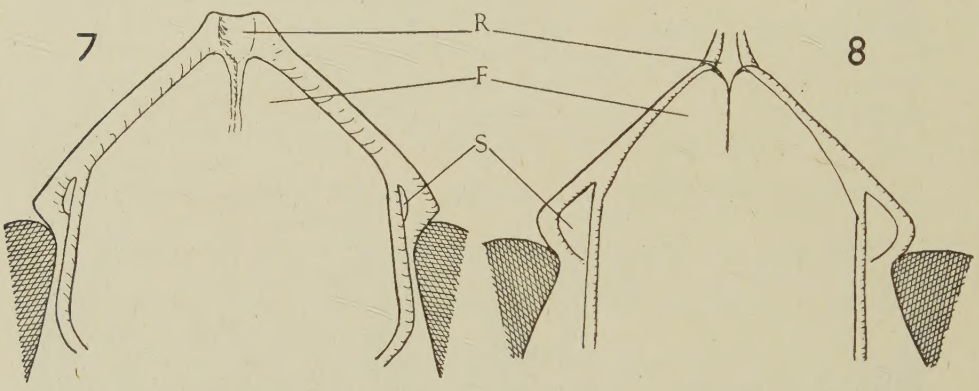
The next step in this series is offered by *Eremocharis* (figs. 5 and 16). Here the fastigium is strongly projecting forward, almost flat, with only slight irregular depressions in place of supraocellar foveolae, and has a definite edge; there is scarcely any trace of preocellar foveolae on its vertically sloping sides; the



FIGS. 1–6.—Vertex, dorsal view of:—1, *Asiotmethis muricatus*. 2, *Prionotropis hystrix*, do. 3, *Melanotmethis fuscipennis*, do. 4, *Eremopeza cinerascens*, do. 5, *Eremocharis subsulcata*, do. 6, *Tmethis cisti*, do.—R, frontal ridge; P, preocellar foveola; F, fastigium of vertex; O, lateral ocellus; S, supraocellar foveola.

resulting vertex is quite analogous to that of the Pamphagini (see figs. 7 and 8) except that all carinae are obsolete.

A variation of the *Asiotmethis* type of vertex in exactly the opposite direction is found in *Glyphanus* (fig. 11), where the fastigium slopes roundly forward and sideways, all carinae are obliterated and only traces of preocellar foveolae remain. Thus, an apparently very primitive structure is obtained, but an examination of nymphs proves that a secondary reduction occurs during postembryonic development from a type very close to *Asiotmethis*. A further simplification can be seen in *Tuarega* (fig. 15), where the vertex is broadly rounded, practically without any trace of carinae or foveolae; in this case, nymphs are similar to adults, which may suggest either that this is a genuine primitive condition, or that the simple structure of vertex is firmly established already in the nymphal stage. I am inclined in favour of the second alternative.



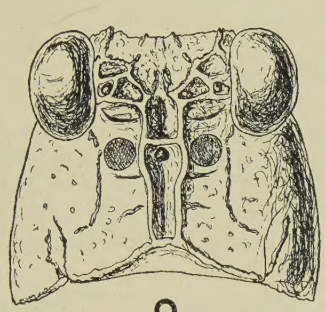
Figs. 7–8.—7, *Haplotropis brunneriana*, vertex. 8, *Paraeumigus* sp., do.—R, frontal ridge; F, fastigium of vertex; S, supraocellar foveola.

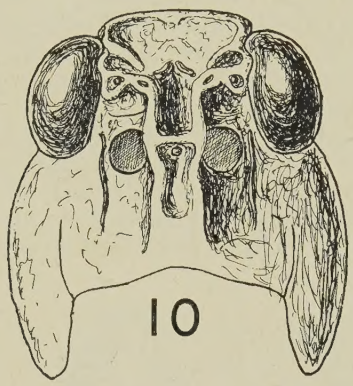
The genera mentioned above form an almost linear sequence, as follows: *Eremocharis–Melanotmethis–Asiotmethis* (*Pezotmethis*, *Atrichotmethis*, *Iranotmethis*)*–Glyphanus–Tuarega*.

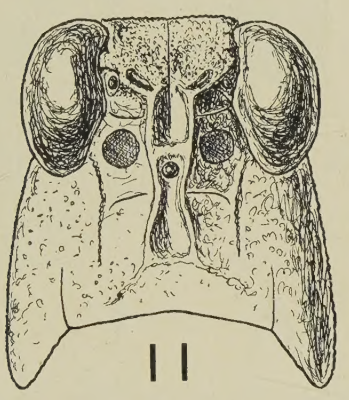
A side-branch of this series is offered by the genera *Filchnerella*, *Rhinotmethis* and *Tmethis*, where the vertex is narrow, concave and sloping forward, but its side margins have a tendency to rise above the level of the compound eyes. In *Tmethis* (figs. 6 and 14) the result is that a narrow supraocellar foveola is placed on a laterally sloping plane, while the preocellar foveola disappears. In the other two genera, the margins of vertex are less raised, the supraocellar foveola is on a weakly sloping plane and the preocellar present, so that a complete transition between *Asiotmethis* and *Tmethis* is obtained. Since the nymphs of *Tmethis* show a broad, flat vertex very similar to that in adult *Asiotmethis*, the progressive narrowing of the vertex in the series *Asiotmethis–Filchnerella–Rhinotmethis–Tmethis* should be regarded as reflecting the probable evolutionary trend. The extreme condition as seen in *Tmethis* (fig. 6) is greatly reminiscent of the true Pamphagine vertex (figs. 7 and 8).

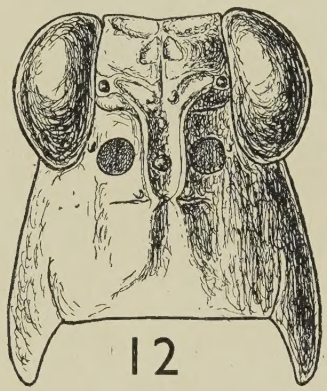
Another principle in the transformation of the *Asiotmethis* type of vertex is seen in *Prionotropis* (figs. 2 and 10), where all carinae are thick and strongly developed at the expense of the foveolae, which are reduced to small pits, the

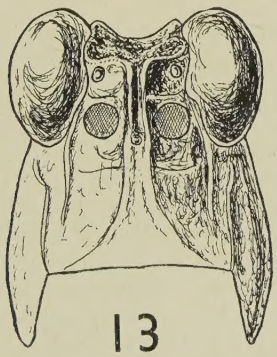
preocellar one being widely separated from the supraocellar. The resulting structure is closely similar to that observed in true PAMPHAGINAE (figs. 7 and 8), the difference being due only to the greater width of the vertex in *Prionotropis*.

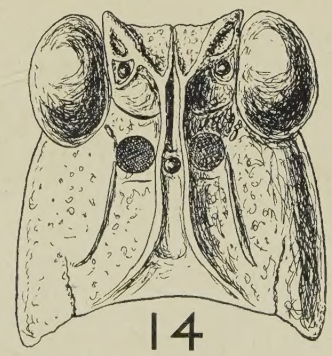










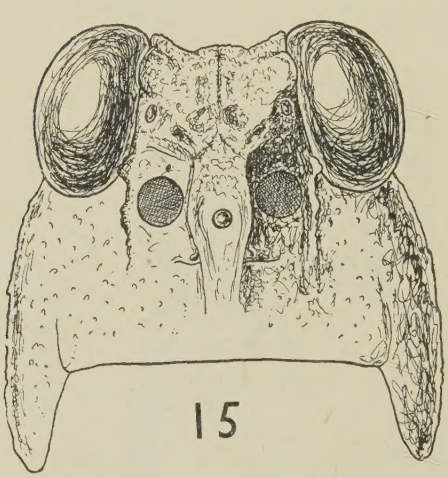


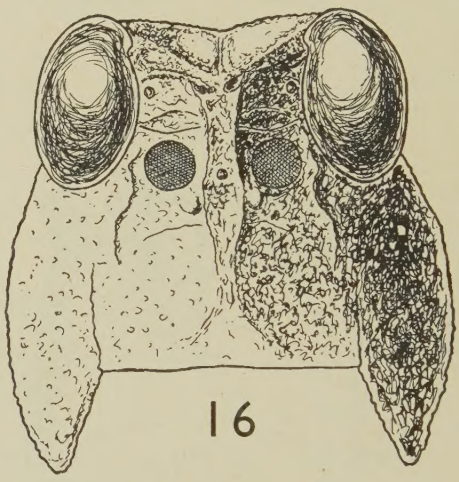
FIGS. 9–14.—Vertex of:—9, *Asiotmethis muricatus*; 10, *Prionotropis flexuosa*; 11, *Glyphanus obtusus*; 12, *Eremopeza cinerascens*; 13, *Thrinchus* sp.; 14, *Tmethis pulchripennis asiaticus*.

Another group of genera with regard to the structure of vertex comprises *Eremopeza* (figs. 4 and 12) and *Eremotmethis*. Here the top of the vertex is almost horizontal and flat, or even weakly convex, but its sides are swollen,

with the result that all carinae are obliterated, while the fastigium and the foveolae are represented by scarcely perceptible (often quite obsolete) depressions. A study of nymphs of both these genera shows that this type of vertex is developed from a condition very similar to that observed in *Glyphanus*, by the inflation of sloping fastigial sides and the smoothing of carinae. The vertex of *Utubius*, *Thrinchus* (fig. 13), and *Strumiger* is only a variation of the same type, due to the narrowing of the vertex and complete obliteration of all carinae and foveolae.

Pronotum.—There are three main types of pronotal structure in Thrinchini, and the simplest is found in *Tuarega*, where the whole thorax is depressed, the pronotum transversely rounded in prozona and flattened in metazona, with the median carina obsolete, or represented only by a weak raised line. A similar condition is found in *Eremocharis* (fig. 17), where the median carina is

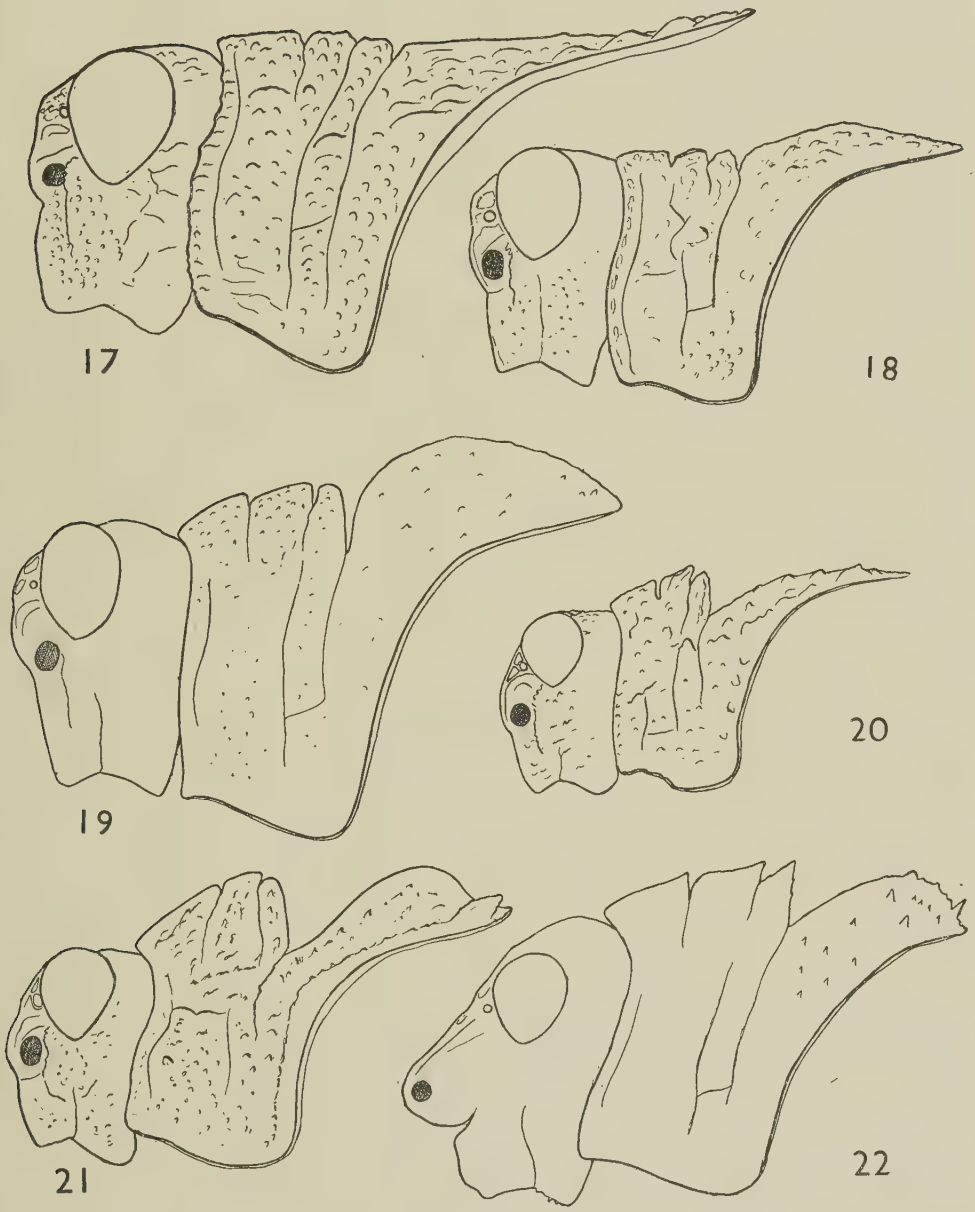




Figs. 15–16.—Vertex of:—15, *Tuarega insignis*; 16, *Eremocharis subsulcata*.

but slightly raised in prozona and linear in metazona. The second type is characterised by the median carina being definitely more developed in the prozona than in the metazona. In some genera, e.g. in *Atrichotmethis*, *Melanotmethis*, *Pezotmethis*, *Glyphanus*, *Utubius* and *Thrinchus*, the metazonal carina is very weak, linear, but in others, such as *Asiotmethis* (fig. 20), *Tmethis* (fig. 21), *Filchnerella*, *Rhinotmethis* (fig. 22) and *Eremotmethis*, the carina in the metazona is distinctly raised, but less so than in the prozona, and always descends steeply to the deep typical transverse sulcus, so that the pronotum is saddle-shaped. The third type of pronotum is that compressed laterally, with the profile of the whole median carina forming an arch which is briefly interrupted by transverse sulci. In the more primitive form this type is observed in *Eremopeza cinerascens* (fig. 18), but in other species of the same genus, e.g. *E. gibbera* (fig. 19) and in *Iranotmethis*, the crest becomes very high and regular. This type culminates in the pronotum of *Prionotropis* (fig. 23), where the carina is regularly arched, laminate and scarcely interrupted by transverse sulci. Further development of the pronotal type consists in the sulci becoming almost obsolete and is found already in the true Pamphagini (figs. 24, 25).

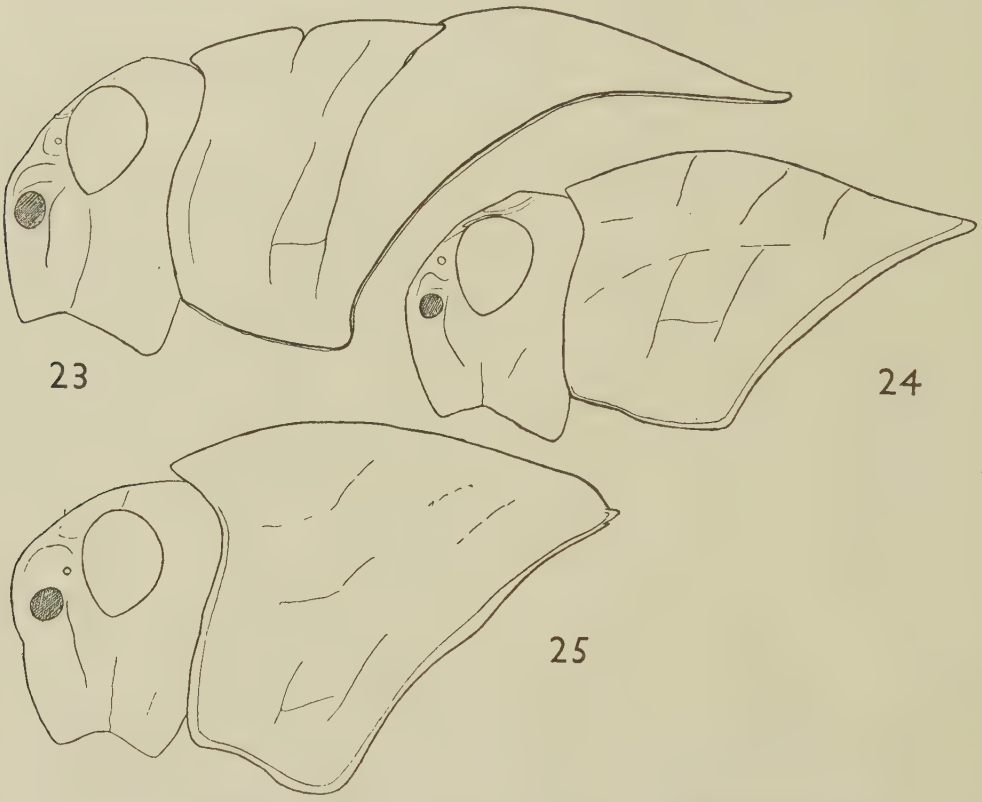
Other modifications in the pronotal structure consist particularly in the



FIGS. 17–22.—Pronotum of:—17, *Eremocharis subsulcata*; 18, *Eremopeza cinerascens*; 19, *Eremopeza gibbera*; 20, *Asiotmethis muricatus*; 21, *Tmethis pulchripennis asiaticus*; 22, *Rhinotmethis hummeli*.

variations of the metazonal edges. In the simpler cases (*Tuarega*, *Atrichotmethis*) the metazona becomes simply thinner towards the margins, but in some genera (*Asiotmethis*, *Tmethis*) the metazona is fringed with narrow laminate edges, while in others (*Pezotmethis*, *Eremocharis*) its margins are, on the contrary, distinctly incrassate. These modifications are clearly secondary, but they supply useful generic characters.

A special feature of the median pronotal carina in *Eremocharis* is the presence of a fine sulcus along its middle line. This is an interesting case of the retention



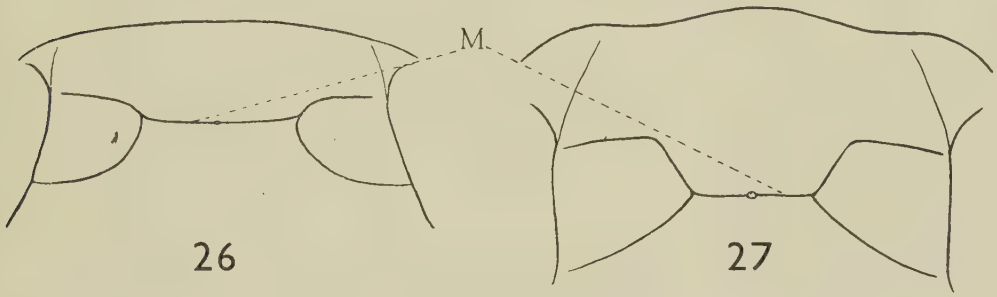
FIGS. 23–25.—Pronotum of:—23, *Prionotropis hystrix*; 24, *Haplotropis brunneriana*; 25, *Tropidauchen miramae*.

in the adult stage of an early character, since the sulcation of the carina is an evidence of its origin as two folds and can be observed in nymphs of other genera.

STERNUM.—The *prosternum* in most genera of Thrinchini is of normal structure, but its anterior edge is always slightly raised, forming a narrow collar. In some genera (*Filchnerella*, *Rhinotmethis*, *Thrinchus*) this collar is strongly developed and bears indentations or projections of different shape. These modifications of the collar are found in other PAMPHAGINAE as well. The median portion of the prosternum is only weakly convex, but in *Strumiger* it is globular, a condition typical of many Pamphagine genera. These modifications of prosternal structure have probably no phylogenetic significance and appear to be dependent on habits.

The *mesosternum* is characterised by short and broad, always widely separated, lobes, and particularly by the shape of the mesosternal suture (M, figs. 26, 27), which is never straight, but more or less inflexed backwards between the lobes. This character is found again only in the group Egnatii, usually referred to the Oedipodinae, but clearly different from that subfamily in many respects (particularly in the absence of the discoidal vein of the elytra).

Abdomen.—In all Thrinchini the abdomen is more or less compressed laterally, the extreme condition being reached in *Prionotropis*. Apparently correlated with this compression is the development of median folds, at the posterior ends of the tergites, which vary considerably between different genera. In some genera (e.g. *Eremopeza*) the tergites are completely without folds, except the first, which bears a large hump-like compressed fold in all genera (but not in strongly brachypterous species). The persistence of this fold on the first segment and its great size suggest that it may have some physiological function, and its anatomical structure as well as its rôle in behaviour deserve a close study. A tendency to develop sublateral folds on tergites is observed mainly in brachypterous members of the group in which the abdomen is not covered by the elytra.



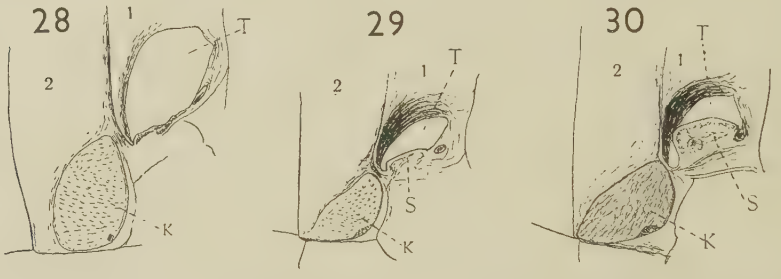
Figs. 26–27.—Mesosternum and metasternum, ventral view; M, mesosternal suture. 26, *Asiotmethis muricatus*. 27, *Eremopeza gibbera*.

Tympanal Organ.—The first tergite of the abdomen always bears a well-developed *tympanal organ* (figs. 28, 29, 30, T). In all genera the tympanal membrane is placed somewhat obliquely to the body axis, its posterior margin being more deeply sunk into the body than the anterior; in *Prionotropis*, however (fig. 28), the rim of the tympanum is scarcely higher posteriorly than anteriorly. Another feature consists in the development of the subtympanal lobe (fig. 30, S), which is in most genera rather large, covering one-third to one-half of the membrane, while in others (*Asiotmethis*, fig. 29) it is small, and in *Prionotropis* (fig. 28) the lobe is scarcely discernible. In these details of tympanal structure, *Prionotropis* is definitely the least specialised, while at the same time approaching most closely the rest of the Pamphaginae.

According to Knetsch (1939, *Arch. Naturgesch.* (n.f.) **8** : 26), the sensory apparatus of the tympanum in Thrinchini is remarkable for the reduction in the number of its component parts, from four in the normal Acrididae to only two. Similar reduction is reported by Knetsch in the Pamphagine genera *Lamarckiana*, *Acinipe* and *Ocneridia*. A more detailed investigation of the sensory apparatus throughout the Pamphaginae and Acrididae in general would be of interest.

Krauss's Organ.—The second abdominal tergite of all Thrinchini bears in its lower anterior corner a specialised plate, which has always been considered

as a sound-producing organ. It was first mentioned by Stål (1873, *Rec. Orth.* **1** : 118), then by Graber (1875, *Denkschr. Akad. Wiss. Wien*, **36** : 87), and described in considerable detail by Krauss in *Prionotropis hystrix* (1878, *Sitzber. Akad. Wiss. Wien.* (1), **78** : 41). The plate undoubtedly represents a special organ, which I propose to call *Krauss's organ*. It can be found in all known genera of Thrinchini, as well as in practically all other Pamphaginae, except some completely apterous genera where its reduction is certainly a secondary phenomenon. Krauss's organ (figs. 28, 29, 30, K) consists of a more or less oval plate, externally clearly raised above the level of the second tergite, and margined by a distinct chitinous rim on the inner side of the body wall; its surface is usually rough and covered either with small tubercles (figs. 28, 29) or with fine ridges (fig. 30). In the lower anterior corner of the plate the opening of the spiracle can be seen. The plate, although appearing very rough and strongly chitinised, is actually very thin and elastic; when carefully opened, it will be seen that it forms the cover of a shallow cavity, the bottom of which is the body wall. As only dry material was available for the present study,



Figs. 28–30.—28, *Prionotropis hystrix*, first and second abdominal tergites of the right side. 29, *Asiotmethis muricatus*, do. 30, *Tmethis cisti*, do.—1, first tergite; 2, second tergite; K, Krauss' organ; S, subtympanal lobe; T, tympanum.

it was impossible to discover whether the cavity is in communication with the tracheal system, but it appears that the spiracle, although embodied in Krauss's organ, leads not into its cavity but into the spiracular trachea, which passes under the organ. The organ, as a whole, resembles a flat chamber with a pliable cover bearing tubercles, or ridges. Graber (*loc. cit.*) and Krauss (*loc. cit.*) assumed that the organ has a stridulatory function, and the last-named author has even discovered an area on the inside of the hind femur close to its base, bearing minute rounded tubercles, which he thought would produce sound when rubbed against the abdominal plate, though he did not record observations on live insects in support of this view. Brunner (1882, *Prodr. europ. Orth.* : 81) disputed the sound-producing rôle of the organ, and Pantel (1886, *An. Soc. esp. Hist. nat.* **15** : 274) has observed stridulation in *Prionotropis flexuosa* without any movement of the femur; this was produced by the special organ of the hind-wing and mid-tibia (see below), and Krauss's organ played no part in it. Thus, there is no observational evidence that this organ is used in sound-production, and its structure, although imperfectly known, does not, on the whole, suggest this function. Indeed, although the surface of the plate is rough, the plate is, as Krauss himself noticed, remarkably thin, responding to the slightest pressure. Moreover, the ridges on the plate, e.g. in *Tmethis* (fig. 30), besides being too fine, run in the wrong direction, while in some other Pamphaginae that also possess Krauss's organ, e.g. in *Akicera*, the surface

of the plate is even quite smooth. The specialised femoral area, mentioned by Krauss as the counterpart of the stridulatory mechanism, is in many genera absent, or bears only fine furrows which cannot possibly produce the desired effect. In fact, no correlation can be observed between the surface sculpture of the plate and that of the femoral base. The only exception is offered by the genus *Trachypetrella*, where a real sound-producing mechanism has developed on the basis of Krauss's organ, but even there the organ itself remains as described, and two lamellate ridges appear immediately below it, on a second swelling of the tergite; the base of the hind femur has large, acute tubercles, quite distinct from anything observed in Thrinchini and placed on the middle section of the base, not at its lower edge, where only dense minute tubercles are present.

Thus, the structure of Krauss's organ does not suggest a sound-producing function. Its occurrence amongst Thrinchini and other PAMPHAGINAE supplies similar evidence. The organ is present and equally well developed, as already pointed out by Brunner (*loc. cit.*), in both sexes, and in the apterous and the fully-winged species, which would certainly be unusual for sound-producing organs. Since, moreover, all the winged Thrinchini possess a stridulating mechanism of a different kind, discussed below, the presence of a second mechanism would be surprising.

Inadequate knowledge of the anatomical structure, and complete absence of histological data and of observational evidence, precludes me from ascribing a definite function to Krauss's organ, but it might be suggested that it could play some part as a pressure-recording mechanism. It might function either as a "sense of position" organ, recording the pressure of the femur against the abdomen (for this purpose the organ appears to be too elaborate) or even for the sense of air-pressure (on the principle of an aneroid barometer, as suggested by my friend, Dr. F. E. Zeuner). These are, however, purely hypothetical suggestions, and the problem has to await a student attracted by its anatomical and physiological aspects.

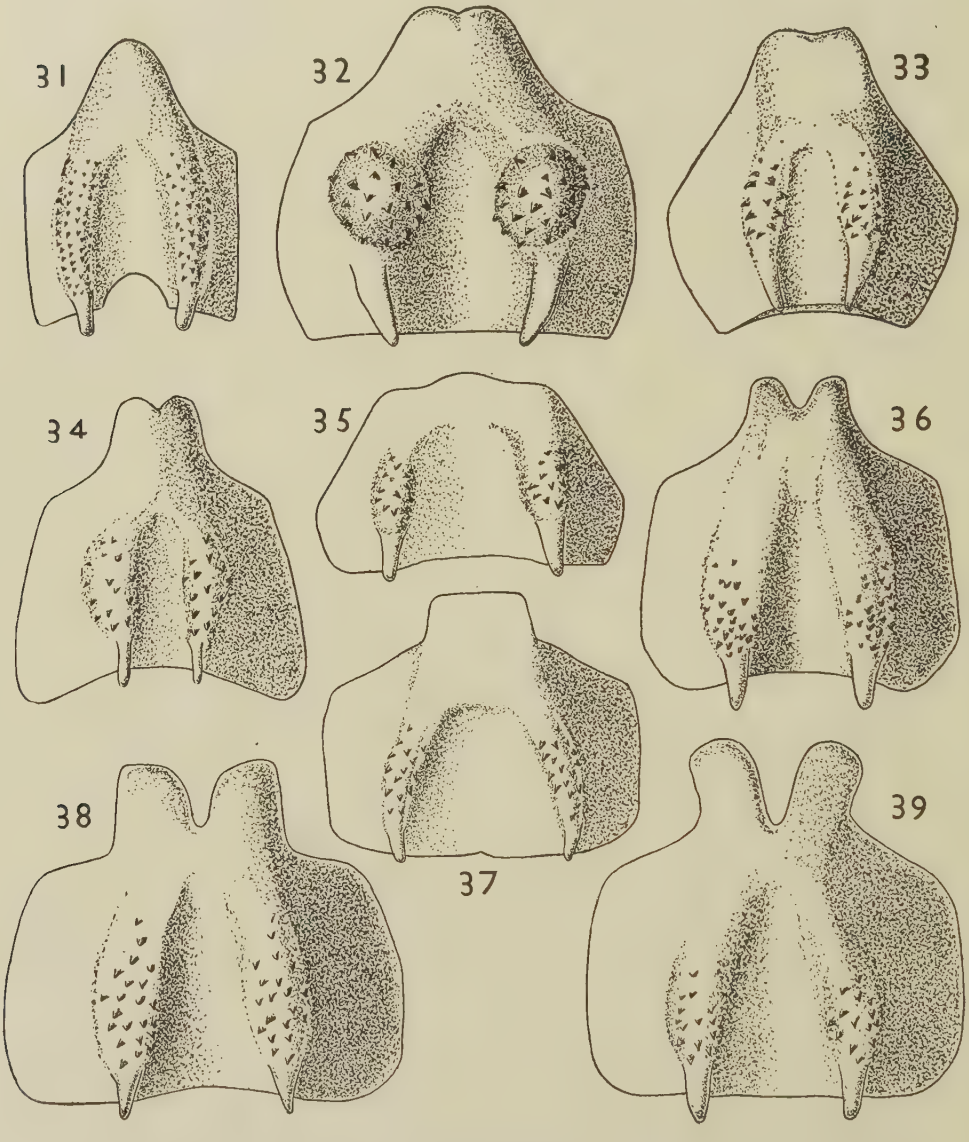
For taxonomic purposes, Krauss's organ supplies good characters, since the sculpturing of its surface varies generically. Phylogenetically, it provides the best evidence of the intimate relationship between the Thrinchini and the other PAMPHAGINAE (see p. 26).

GENITALIA.—The external *male genitalia* in Thrinchini are, on the whole, of the normal Acridid type and of simple structure. Some specialisation is found only in the supra-anal plate of *Prionotropis*, which is very roughly sculptured, furrowed along the middle and transversely across; in this respect, there is again a resemblance to some true PAMPHAGINAE. Another peculiarity is the tendency of the male subgenital plate to become bi-tuberculate apically. This is found constantly in *Thrinchus*, *Strumiger* and *Atrichotmethis*, and, as a mere individual phenomenon, also in *Prionotropis hystrix* and *Appulum* (see under that species, p. 39).

The *internal male genitalia* of Thrinchini have been studied by Roberts (1941, *Proc. Acad. nat. Sci. Philadelphia* **93** : 214–217), and found to be of the same relatively simple general type as in true PAMPHAGINAE. An outstanding feature of this type is the broad, plate-like epiphallus armed with two groups of spines; a similarly shaped epiphallus was not found in any other group of ACRIDIDAE. A more detailed discussion of the internal genitalia will be offered later (p. 23). Variations in the shape of the epiphallus provide good generic characters (figs. 31–39).

The *ovipositor* of the female is of the simplest structure in *Prionotropis* (fig. 40), but in the majority of genera (figs. 41, 66–71) the lower valve has an

obtuse external tooth, concave narrow apical portion, and a faint indication of an oblique ridge, which becomes well developed in *Tuarega* (fig. 42). These variations may depend on oviposition habits, and their phylogenetic significance appears to be small.

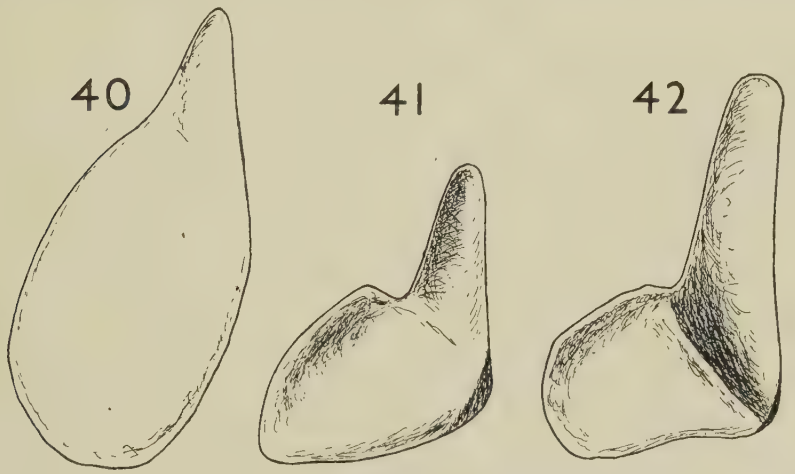


FIGS. 31–39.—Male epiphallus. 31, *Thrinchus* sp.; 32, *Pezotmethis tartarus*; 33, *Eremopeza gibbera*; 34, *Tmethis pulchripennis pulchripennis*; 35, *Asiotmethis heldreichi ovipennis*; 36, *Tmethis pulchripennis asiaticus*; 37, *Melanotmethis fuscipennis*; 38, *Tmethis cisti clavelii*; 39, *Tmethis cisti tunensis*.

The *internal genitalia* of the female have been studied by Slifer (1940, *J. Morph.* **66** : 175), who has found that all members of the Thrinchini,

PAMPHAGINAE and PYRGOMORPHINAE that have been examined are characterised by the absence of glandular pouches at the anterior end of the genital chamber, and by a single recurved diverticulum of the spermatheca. The complete agreement in the anatomy of genitalia between Thrinchini and other PAMPHAGINAE is to be noted.

ELYTRA AND WINGS.—The venation of the *elytra* in Thrinchini is of the relatively simple type characteristic of the subfamilies CATANTOPINAE, PAMPHAGINAE and PYRGOMORPHINAE. Its main features are: (1) open discoidal area (normally closed in ACRIDINAE and OEDIPODINAE); (2) absence of false discoidal vein (which is typical of OEDIPODINAE, see Uvarov, 1942, *Trans. Amer. ent. Soc.* **67** : 336); (3) absence of expanded areas with regular venation (particularly typical of a large section of ACRIDINAE provided with the elytro-femoral stridulating mechanism); and (4) generally irregular network (found also in other subfamilies though less consistently). When the elytral venation



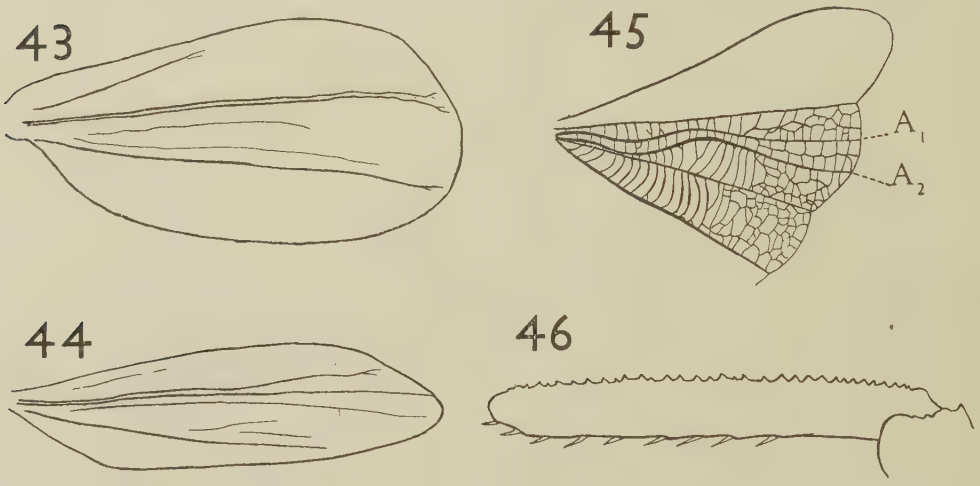
FIGS. 40–42.—Lower lobe of the ovipositor, ventral view. 40, *Prionotropis hystrix*; 41, *Asiotmethis turritus*; 42, *Tuarega insignis*.

of Thrinchini is compared with that of the fully-winged PAMPHAGINAE, no difference can be found from *Adephagus* and *Akicera*, whilst the group Porthetini (*Lamarckiana* and allied genera) differs only in the stridulatory specialisation of the costal area, which is clearly a secondary phenomenon.

The *wing* venation of the Thrinchini is characterised by specialisation in the two areas behind the vena dividens; externally, these areas correspond to the second and third lobes of the outer margin of the wing. The specialisation concerns the first and the second axillary veins, if Saussure's (1884, *Prodr. Oedipod.*) nomenclature is used, or the two " secondary anal veins " of Snodgrass (1929, *Smithson. misc. Coll.* **82** (2) : 85). The first of these veins (fig. 45, A_1) is somewhat sinuate, but the second (A_2) much more so, being also incrassate; on the underside it is strongly compressed, forming a sharp ridge. The area between A_2 and the following vein (first false radial vein of Saussure; first concave anal vein of Snodgrass) is expanded, with regular cross-veins; the following area is also expanded, often convex above and even more regularly cross-veined. The ridged A_2 and the two tympanate areas represent a stridulating organ, together with the serrate upper edge of the median tibia (fig. 46).

The sound is produced (Pantel 1886, *An. Soc. esp. Hist. nat.* **15** : 273) by tibial movement forwards and backwards against the lower surface of the partially extended wing with its acutely carinate axillary vein, while the tympanate areas serve for amplifying the sound. According to Pantel, the sound is produced mainly when a flying insect is on the point of alighting, but it would be of interest to see whether the stridulation also forms a part of mating behaviour, or is produced under any other stimuli.

The generic variation in the wing venation depends on the degree of stridulatory specialisation in the axillary veins. In most genera it is nearly as great as in *Prionotropis*, illustrated above, but in others (*Atrichotmethis*, *Eremocharis*) it is considerably less, the axillaries being only weakly sinuate, and it is always less marked in the female sex. It is noteworthy that the greatest specialisation is found in *Prionotropis*, which in every other respect approaches most closely the rest of the PAMPHAGINAE, although the latter



FIGS. 43–46.—**43**, *Asiotmethis heldreichi ovipennis*, right elytron of female. **44**, *Glyphanus obtusus*, do. **45**, *Prionotropis flexuosa*, part of right wing of male; A_1, first axillary vein; A_2, second axillary vein. **46**, *Prionotropis flexuosa*, right middle tibia of male.

show only weak sinuation of the axillaries (in *Porthetis* and *Akicera*). However, an equally weak degree of wing specialisation is found in the South African Thrinchini, e.g. *Batrachotetrix* and *Batrachornis*, so that this character cannot be regarded as separating Thrinchini from other PAMPHAGINAE (except the tribe Porthetini which is distinct in having non-specialised wings, but possessing instead a peculiar elytral stridulatory mechanism working in conjunction with modified inner apical spurs of the hind tibiae).

A tendency to *brachypterism* may be considered as characteristic of the whole group, except the genera *Thrinchus*, *Utubius*, *Strumiger*, *Atrichotmethis*, *Tuarega*, *Eremotmethis* and *Eremopeza*. In no case, however, does a complete loss of elytra and wings occur, while this is typical of most other PAMPHAGINAE. The greatest degree of reduction is seen in *Glyphanus*, where the elytron (fig. 44) is reduced to a narrow pad, and the wing absent, while in other genera the elytron, even when very short, is still oval (fig. 43) and there is always a rudimentary wing. The relative degree of brachypterism of the two sexes in the same species is variable. Sometimes the male is fully-winged and the female

has only somewhat abbreviated elytra and wings (*Iranotmethis*, *Melanotmethis*, *Asiotmethis cucullatus*, etc.); or both sexes are almost equally brachypterous, the female somewhat more so (most *Prionotropis*, *Pezotmethis*), or the male is fully macropterous while the female is strongly brachypterous (*Asiotmethis heldreichi dimorphus*, *Rhinotmethis*, *Prionotropis flexuosa*). So far, no cases are known of occasional macropterism in the normally brachypterous species.

Legs.—Modifications of the normal Acridid leg structures in Thrinchini concern only the median tibia and the hind femur.

In all genera and species provided with wings, the *median tibia* bears a more or less developed series of tubercles along the dorsal edge, which serve as an active part of the stridulatory mechanism (see above), but they tend to become less regular and finally disappear altogether in the strongly brachypterous species. When only the female is brachypterous, it has a smooth tibia, although the male may have well-developed tubercles (e.g. *Asiotmethis heldreichi dimorphus*), though in *Prionotropis flexuosa* even the female still has a serrate tibia, which cannot be functional owing to strong reduction of the wings.

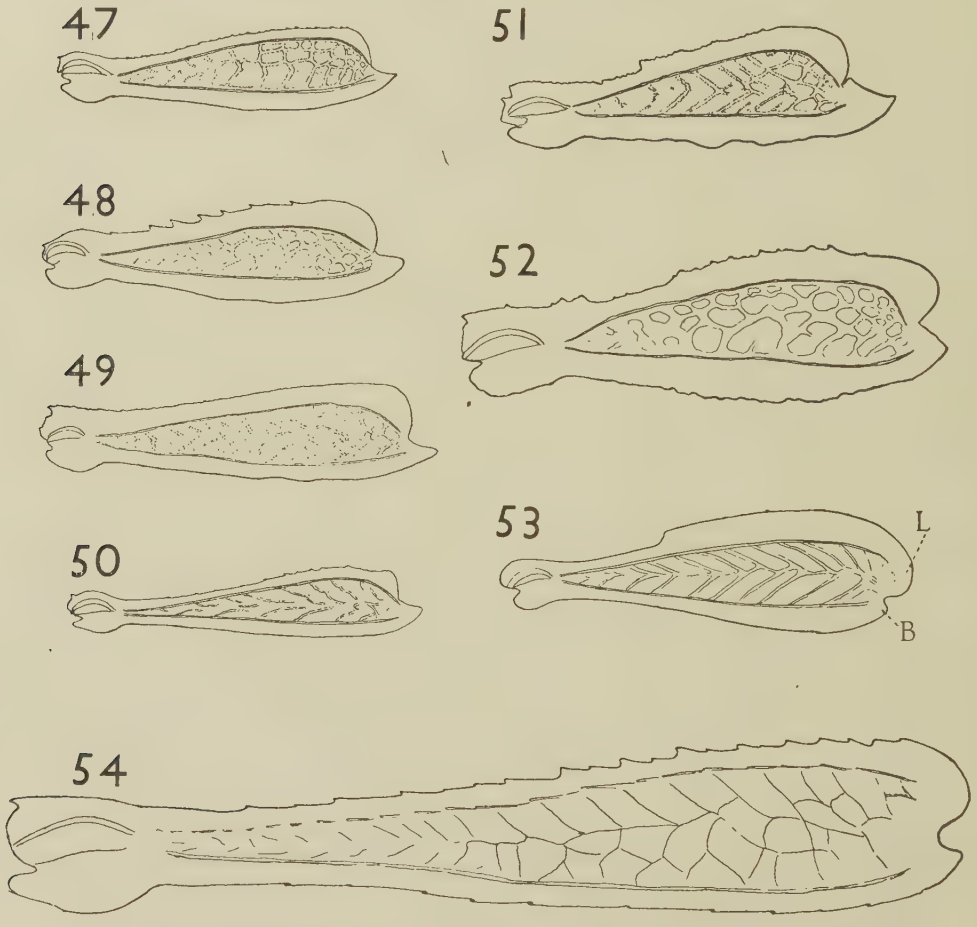
The *hind femur* in all the Thrinchini (as well as in the Pamphaginae in general and in the Pyrgomorphinae) presents two peculiarities. One is the shape of the base, which in all Acrididae consists of the base proper (fig. 53, B), placed below and serving for the trochantero-femoral articulation, and a rounded upper basal lobe (fig. 53, L). Normally in Acrididae the lobe is more prominent anteriorly than the base and overhangs it (fig. 53), but in the groups under discussion the lobe is reduced and the base is attenuated (figs. 47–52). This may have the effect of permitting the femur (together with the trochanter which is almost fused with it) to rotate on its long axis more freely than is the case in other Acrididae. The result of such rotation would be to bring the lower edge of the femoral base in contact with Krauss's organ on the first tergite, but the purpose of such contact cannot be understood until the function of Krauss's organ is known. If the above explanation is correct, there should be some difference in the musculature in the base of the femur between normal Acrididae and the aberrant groups.

The second peculiar feature of the hind femur in the same groups is the marked irregularity of the " fish-bone pattern " on its middle area which is so typical of Acrididae in general (compare figs. 47–52 with 53 of the normal Acridid). This is clearly an instance of retrogression of a character, probably due to the reduction in jumping power and consequent degeneration of the complex muscle (levator of tibia) attached to the " fish-bone " ridges. The reduction of the upper basal lobe, mentioned above, may be also partly due to this degeneration, since the lobe in normal Acrididae (fig. 53) accommodates parts of the femoral muscle.

The general shape of the femur offers considerable variation (figs. 47–52), and often supplies characters of generic value.

The *hind tibia* of Thrinchini is usually more or less compressed laterally, and armed with a moderate number of strong spines. The spines of the outer series have a tendency to become laterally compressed, and this is particularly strongly expressed in *Prionotropis*. The inner spines are somewhat longer and more curved than the outer. Special interest is attached to the terminal spines (not to be confused with the movable spurs) of the hind tibia. The diagnostic value of this character was always rated highly by taxonomists, though Stål (1875, *Bih. Sven. Vet. Akad. Handl.* 3 (14) : 23), who was the first to discuss it, has pointed out that the absence of a terminal spine may be of less importance than some other characters, and the lack of both terminal spines in *Thrinchus*

did not prevent him from including this genus in one group with *Eremobia* (now *Tmethis*) and *Cuculligera* (now *Prionotropis*), both possessing a well-developed pair of spines. Saussure (1884, *Prodr. Oedip.*; 1888, *Addit. Prodr. Oedipod.*), however, attached great importance to this character and used it alone for separating his "legions" of Thrincites and Eremobiites, which are indistinguishable in any other feature. Later authors endorsed this opinion



FIGS. 47–54.—Right hind femur. 47, *Eremopeza cinerascens*; 48, *Prionotropis flexuosa*; 49, *Atrichotmethis semenowi*; 50, *Thrinchus* sp.; 51, *Asiotmethis muricatus*; 52, *Tuarega insignis*; 53, *Oedipoda miniata*; 54, *Agriacris* sp.

by maintaining two separate subfamilies, THRINCHINAE and EREMOBIINAE (=BATRACHOTETRIGINAE). This divergence of opinion induced me to undertake a fresh investigation of the problem as regards *Thrinchus* and allied genera. Abundant material of *Thrinchus* spp. and a fair series of *Strumiger desertorum* have been examined and a complete lack of both terminal spines in adults confirmed, but no nymphs of these two genera were available for study. The third genus, *Utubius*, however, provided valuable information. In the majority of adults there are terminal spines on both sides of the tibia, but they are always

small, often irregular; the outer one is particularly apt to become reduced to almost a tubercle, while in one male it is completely lacking. Out of eight nymphs which I was able to examine, seven had both spines relatively better developed than in adults, and in one the outer spine was absent. This suggests that the disappearance of terminal spines is a secondary phenomenon, and that this character is not yet stabilised in *Utubius*, a genus which in other respects (*e.g.* structure of prosternum) also occupies a position intermediate between *Thrinchus* and other genera of the group. A similar result was obtained from examining a series of *Batrachornis perloides*, a South African member of Saussure's Eremobiites; here the outer spine is always smaller than the inner and is occasionally lacking on one tibia, but present on the other. Thus, the loss of terminal tibial spines has to be regarded in this group as a recent development, and the use of this character for the separation of two subfamilies is certainly unjustifiable. On the other hand, the presence of the spines in the majority of Thrinchini suggests once more their close affinity with the true PAMPHAGINAE. Saussure (1887, *Spicil. ent. Genève.* **2**: 16), who has found it almost impossible to draw a line between the two groups, was particularly disturbed by the presence of terminal spines in the " Eremobiens," because " *a priori*, il semblerait que les Eremobiens ne devraient posséder aucune épine semblable, car ils ne sont en somme que des Oedipodiens adaptés au désert et les Oedipodiens n'en possèdent pas. On dirait donc volontiers que les Eremobiens n'ont pris cette épine que pour mieux ressembler aux Pamphagiens." This citation shows merely how misleading has been Saussure's *a priori* conception of Eremobiites being highly specialised OEDIPODINAE, while actually the latter are much more highly developed as is shown by elytral venation (see p. 30). On the other hand, the inclusion of the Thrinchini in the PAMPHAGINAE makes the presence of terminal spines in nearly all of them very significant, while their absence in *Thrinchus* and *Strumiger* is certainly due to secondary reduction. A study of the nymphs of these two genera would be of interest in this respect.

The *tarsal arolia* of Thrinchini are usually reduced in size, more so in the purely deserticolous genera, in obvious correlation with the restriction of climbing habits.

RELATIONSHIP AND PHYLOGENY.

RELATION OF THRINCHINI TO OTHER PAMPHAGINAE.—The comparative analysis of the morphological characters of the Thrinchini and of the PAMPHAGINAE in general, presented above, reveals that the two groups agree completely in nearly all important respects, such as the structure of the sternum, the hind femur, the internal male and female genitalia, the presence of Krauss's organ, and the type of elytral venation (leaving aside the specialisation found in *Porthetis* and allied genera of PAMPHAGINAE). It is therefore quite impossible to maintain the Thrinchini as a subfamily (still less as two subfamilies, BATRACHOTETRIGINAE and THRINCHINAE) distinct from PAMPHAGINAE, and they should be regarded as merely a tribe of the latter subfamily. The position of the Thrinchini in the subfamily PAMPHAGINAE cannot, however, be fully appreciated without a survey of other tribes comprised in the subfamily. A subdivision of PAMPHAGINAE into " sections " has been proposed by I. Bolivar (1916, *Gen. Insect.* **170**: 5), but it was based on formal characters and must be modified. As I have no intention of presenting a complete revision of the subfamily, the following remarks should be regarded as merely suggesting a temporary arrangement which appears more natural than that proposed by I. Bolivar.

Two of I. Bolivar's nine sections have to be excluded from PAMPHAGINAE.

The first is the section Pamphagodes, with two genera: *Charilaus* Stål 1875 (= *Cephalacris* I. Bolivar 1916, **syn. n.**; the reasons for the synonymy have been given in Uvarov 1929, *Ann. S. Afric. Mus.* **29 :** 66) and *Pamphagodes* I. Bolivar 1878. These two genera belong to the Pamphagine–Pyrgomorphine complex, but stand very isolated. In any case, they find no place amongst the subfamily PAMPHAGINAE because of the complete absence of Krauss's organ even in the fully winged species, and I would suggest attaching them to the PYRGOMORPHINAE, at least until it can be shown that they form a distinct subfamily, as appears probable.

The other section is that of Sygri, comprising the single genus, *Sygrus* I. Bolivar 1889, known from a single female, very imperfectly described and referred to the PAMPHAGINAE apparently only because of its apterism and general habitus; it is probably a Catantopine.

Thus, only seven sections remain, but two of these (Nocarodes and Pamphagi) should be united, making six sections treated by me as tribes. Two new tribes are now distinguished and the tribe Trinchini added. The nine resulting tribes may be briefly characterised, as follows :—

1. **Phrynotettigini** (new tribe). Differs from all other tribes by the normal Acridid type of hind femur (full discussion, p. 27).

Genera: *Phrynotettix* Uhler 1872; *Dracotettix* Bruner 1889; *Litoscirtus* Bruner 1907; *Buforania* Sjöstedt 1920; *Aucacris* Hebard 1929; ?*Conometopus* Blanchard 1851 (not known to me but probably belonging here).

2. *Akicerini*. Antennae ensiform. Fastigium horizontal. Pronotal carina deeply cut by the typical sulcus, in the prozona bi-incised; metazona a little shorter than prozona. Male fully winged, venation of elytra and wings not modified; female with narrow rudimentary elytra. Middle tibia without stridulatory mechanism.

Genus: *Akicera* Serville 1839.

3. *Porthetini*. Antennae strongly ensiform. Fastigium horizontal. Pronotal carina strongly compressed and arched, entire, seldom weakly incised by the typical sulcus (*Saussurea*). Male more or less fully winged, with large number of parallel oblique veinlets in subcostal area; female apterous. Middle tibia without stridulatory mechanism.

Genera: *Porthetis* Serville 1831 [1]; *Lamarckiana* Kirby 1910; *Saussurea* Uvarov 1940 (= *Saussureana* I. Bolivar, 1916); *Hoplolopha* Stål 1876; *Cultrinotus* I. Bolivar 1916; *Stolliana* I. Bolivar 1916; *Bolivarella* Saussure 1887; ?*Pagopedilum* Karsch 1896.

4. **Trachypetrellini** (new tribe). Members of this tribe share with the preceding the stridulatory specialisation of the male elytra, which can be seen even in the brachypterous species, but they are characterised by the depressed body, broad and sloping fastigium practically without margins, filiform antennae, and non-carinate pronotum. Their relationship to Porthetini is exactly analogous to that between Thrinchini and Pamphagini, therefore they can be regarded as Porthetini which have undergone a change of life-form in connection with a change from a shrub-climbing to a geophilous habit. That the change has occurred in that direction, and not in the reverse, is proved by the fact that in the nymphs of *Trachypetrella* and *Aphantotropis* the fastigium is less sloping than in adults and distinctly marginated.

[1] For the reasons stated by me and quoted by Roberts (1941, *Trans. Amer. ent. Soc.* **67** :27) I am unable to accept the change in the application of this name and of *Pamphagus* Thunberg, which he believes to be necessary. The case will be submitted to the International Commission of Zoological Nomenclature for final settlement.

Genera : *Trachypetrella* Kirby 1910 ; *Aphantotropis* Uvarov 1924.

5. **Thrincotropini** nom. n. (to replace the section Schinziae, this generic name being invalid ; see below). Antennae ensiform, or triangular in section. Fastigium horizontal, strongly produced forward. Body strongly elongate. Pronotum cylindrical, with tubercles or spines in place of the median carina. Both sexes brachypterous, or male fully winged and the elytra with normal venation.

Genera : *Thrincotropis* Saussure 1899; *Geloiomimus* Saussure 1899; *Echinacris* Uvarov 1940 (= *Schinzia* Saussure 1899).

6. *Adephagini.* Antennae filiform. Fastigium sloping with carinate margins. Pronotal prozona weakly notched ; metazona subequal in length to prozona. Both sexes fully winged ; elytral venation not modified ; wing venation and middle tibia weakly specialised for stridulation (see p. 17).

Genus : *Adephagus* Saussure 1887.

7. *Thrinchini.* Antennae filiform. Fastigium always broad, margins variable and often absent ; when margins present, there are no distinct preocellar foveolae. Usually with more or less fully developed elytra of normal venation ; wings, when present, with the venation modified for stridulation (see p. 15) ; never completely apterous. Middle tibia with stridulatory serration (except in some strongly brachypterous species).

Genera : those of Palaearctic distribution are fully discussed below. Others are : *Batrachotetrix* Burmeister 1838 ; *Batrachidacris* Uvarov 1939 (= *Bufotettix* Uvarov 1929) ; *Batrachornis* Saussure 1884 ; *Eremotettix* Saussure 1888. The South African genera *Crypsicerus* Saussure, *Crypsiceracris* Miller, *Eneremius* Saussure, *Microtmethis* Kuthy and *Lithidium* Uvarov are so degraded that their affinities are obscure ; they are retained in Thrinchini until further study.

8. *Pamphagini.* Antennae filiform, seldom weakly triangular basally. Fastigium sloping, narrow, with carinate margins and without the preocellar foveola (figs. 7, 8). Apterous, or strongly brachypterous.

In this tribe two of I. Bolivar's sections are united, Pamphagi and Nocarodes, since their differences are too indefinite and formal for satisfactory separation.

Genera : *Paranocarodes* I. Bolivar 1916 ; *Eunothrotes* Adelung 1907 ; *Ocneridia* I. Bolivar 1912 ; *Nocarodes* Fischer v. Waldheim 1846 ; *Nocaracris* Uvarov 1928 ; *Ariasa* I. Bolivar 1912 ; *Eunapiodes* I. Bolivar 1907 ; *Euryparyphes* Fischer 1853 ; *Eumigus* I. Bolivar 1878 ; *Paraemigus* I. Bolivar 1914 ; *Amigus* I. Bolivar 1914 ; *Acinipe* Rambur 1838 ; *Pamphagus* Thunberg 1815 ; *Orchamus* Stål 1876 ; *Purpuraria* Enderlein 1929 ; *Acrostira* Enderlein 1929 ; *Prionosthenus* I. Bolivar 1878 ; *Ocneropsis* Uvarov 1942 ; *Ocnerodes* Brunner 1882 ; *Glauia* I. Bolivar 1912 ; *Pamphagulus* Uvarov 1929 ; *Tropidauchen* Saussure 1887 (referred by I. Bolivar 1916 to Porthetini without sufficient reasons) ; *Haplotropis* Saussure 1888 which was described as a Batrachotetrigine, and again under the name *Staurotylus* by Adelung in 1910, who placed it in the Pamphagidae ; future studies may show that it belongs to a tribe of its own, but for the time being it is best left in the Pamphagini, with which it agrees in the structure of the vertex (fig. 7), while certainly differing in this respect from the Thrinchini.

9. *Finotiini.* Differs from the preceding tribe only by the strongly depressed body and spinose pronotum.

Genus : *Finotia* Bonnet 1884.

The interrelation of the proposed tribes may be best understood from the diagram, which should be regarded as a first attempt at constructing a phylogenetic scheme (fig. 55). The diagram shows that Pamphaginae are

a specialised branch of the Catantopine stock (see p. 29) with which they are connected by the least modified tribe, the Phrynotettigini. The tribes Adephagini and Thrinchini preserve the generalised elytral venation, but have developed a tibio-alar stridulatory apparatus; they differ from each other by the fastigium, which in Adephagini is of the same type as in Pamphagini. The Pamphagini are a large and vigorously developing tribe, which includes mainly arbusticolous and saxicolous forms, in distinction to the geophilous Thrinchini. The small tribe Finotiini is merely an offshoot from Pamphagini. A quite different series is formed by the other four tribes, all characterised by the horizontal vertex. Amongst these, Akicerini is the most primitive tribe, exhibiting close resemblance to certain Phrynotettigini. The Thrincotropini are its highly specialised off-

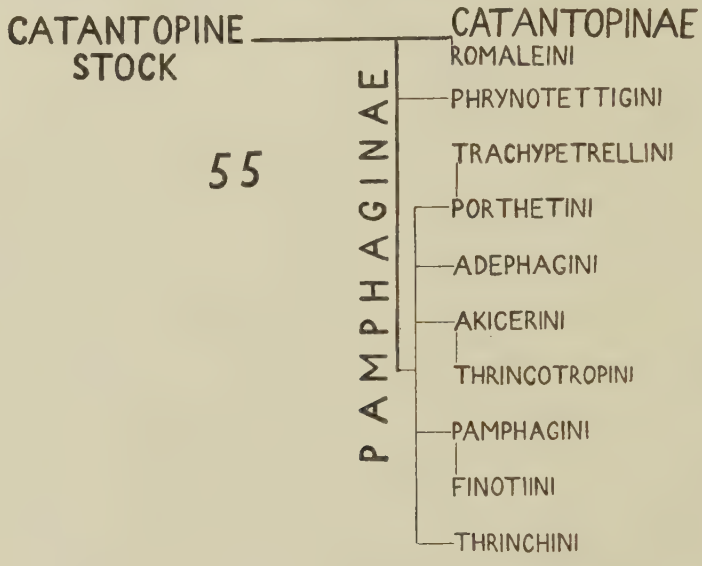


Fig. 55.—Phylogenetic relationship of tribes of Pamphaginae.

shoot. The Porthetini are remarkable for an independently specialised and unique stridulatory mechanism; they are arbusticolous and saxicolous in their habits and life-form, and the Trachypetrellini represent a clear case of secondary specialisation from the Porthetini due to the adoption of a geophilous habit; there is a great resemblance between Trachypetrellini and certain Thrinchini, but this is a clear case of convergence due to a similar mode of life.

Relation of Pamphaginae to other Subfamilies.—The subfamily classification of Acrididae is known to be in need of a thorough critical revision, but much morphological, anatomical and taxonomic work is necessary before this can be undertaken. In the meantime, however, it may be useful to propose tentative schemes of classification which would serve to stimulate both discussion and further research. One attempt of this kind has been made recently by Roberts (1941, *Proc. Acad. nat. Sci. Philadelphia* **93** : 201 ff.), but his conclusions have been based almost entirely on the anatomy of the male copulatory organs and are open to considerable criticism from other points of view, as will be shown below. Since the subfamily Pamphaginae proved to be of special interest for the general classification of Acrididae, the following comparative analysis of its characters, although primarily intended merely to

elucidate the position of PAMPHAGINAE, has provided valuable data for conclusions of a wider character.

Internal genitalia. Roberts (1941, *loc. cit.*) has suggested that all ACRIDIDAE can be divided into two groups according to the structure of the phallic organ. The majority, comprising the subfamilies OMMEXECHINAE, PAULINIINAE, CATANTOPINAE (ROMALEINAE plus CYRTACANTHACRIDINAE of Roberts), OEDIPODINAE and ACRIDINAE, are characterised by a small ejaculatory sac communicating by a gonopore with the spermatophore sac which opens to the exterior by a phallotreme cleft; the latter is usually very short in this group, called Cryptosacci. In the other group, the Chasmosacci, comprising the PAMPHAGINAE and PYRGOMORPHINAE, the ejaculatory sac is very large, and the phallotreme cleft extends along its mid-ventral line to the gonopore. The functional meaning of this modification is not known, but Roberts suggests (*loc. cit.* : 236) that it may be connected with the mechanism of copulation, and, particularly, the transference of the spermatophore. Unfortunately no observations are available on copulation in the PAMPHAGINAE, but the process is probably less complicated than in other ACRIDIDAE, and a spermatophore of a relatively simpler type can be expected. Even with only the morphological evidence available, one cannot unreservedly agree with Roberts' simplification of the problem by contrasting the two types of the ejaculatory sac as if they were fundamentally different. Indeed, it is admitted by Roberts himself (*loc. cit.* : 244), that in the Cryptosacci the phallotreme cleft may also " extend a short way back from the end of the aedeagus," without, however, continuing back into the phallus along the floor of the spermatophore sac. This suggests that the difference is not as fundamental as Roberts maintains, and it is not improbable that more extended studies on members of the group Cryptosacci may reveal transitions to the Chasmosacci. Nor is it possible to accept Roberts' conclusion that the Chasmosacci type is more primitive than that of the Cryptosacci; this is obviously based on the assumption that a morphologically simpler structure is necessarily more primitive phylogenetically.

A similar assumption is made by Roberts with regard to the structure of the aedeagus. According to him, this has two pairs of valves in the Cryptosacci and only one pair in the Chasmosacci, an apparently very clear distinction. Actually, however, some Cryptosacci (of the group Romaleini [2]) have " a much reduced ventral pair of aedeagal valves and in *Chromacris*, Fig. 55, the ventral pair is entirely lacking " (*loc. cit.* : 221). On the other hand, possible " forerunners " of the second pair of valves are present in *Phymateus* of the Chasmosacci (*loc. cit.* : 210), but this interpretation is rejected by Roberts as " very doubtful," without further reasons. This again suggests that the difference between the two groups is much less definite than implied by Roberts. At the same time, he has not supplied any proof that the evolution of the aedeagus occurred by the doubling of the number of valves, and not by the gradual degeneration of one pair out of the original two, a process actually known to occur in Romaleini. From this latter point of view, the " forerunners " of the second pair of valves in *Phymateus* would find a much more natural explanation as rudiments of a pair that has almost disappeared and lost its function, hence the lack of their connection with the phallotreme duct which Roberts (*loc. cit.* : 210) has regarded as the evidence disqualifying them from being recognised as parts of the aedeagus. Arguing on these lines, one

[2] This has always been regarded as the group Tropinoti of the subfamily CATANTOPINAE. Roberts (*loc. cit.*) has raised it to the rank of a subfamily, ROMALEINAE, but this view cannot be accepted for the reasons given below (p. 29).

might as well say that a closed, or sclerotised, tympanum of various wingless ACRIDIDAE is not to be regarded as a tympanum because it is not functional.

When various component parts of the male and female genitalia of PAMPHAGINAE, Romaleini and CATANTOPINAE are compared, a very instructive table (compiled entirely from Roberts' data) is obtained (see table I).

TABLE I.—Internal genitalia of some ACRIDIDAE.

Names of structures	Cryptosacci		Chasmosacci
	CATANTOPINAE	Romaleini	PAMPHAGINAE
Male			
1. Ejaculatory sac	Small	Medium	Large
2. Ventral infold	Small	Medium	Large
3. Phallotreme cleft	Not reaching gonopore		Reaching gonopore
4. Aedeagal valves	Two pairs	Two or one pair	One pair
5. Arch of dorsal valves	Present	Absent	
6. Apodemes of cingulum	Narrow rods	More or less broad plates	
7. Epiphallus	Two lateral pieces connected by narrow bridge		Broad plate with two groups of spines
Female			
8. Glandular pouches	Usually present		Absent
9. Diverticula of the spermatheca	Two	One	

The table shows (1) that there is a much more gradual transition from the Cryptosacci to the Chasmosacci than represented by Roberts; and (2) that the evolution was more likely to have occurred by the process of reduction in the structures Nos. 4, 5, 8 and 9, than in the reverse direction. The structures Nos. 1, 2, 6, became merely larger, and it is only in the phallotreme cleft (No. 3), discussed above, and the epiphallus (No. 7) that somewhat new evolutionary departures may be postulated. With regard to the epiphallus, however, it should be mentioned that the distinctive shape indicated in the table is characteristic only for the PAMPHAGINAE, but in the other subfamily of Roberts' Chasmosacci, PYRGOMORPHINAE, the general shape of the epiphallus is definitely closer to that observed in the Cryptosacci. As for the Pamphagine epiphallus, its plate-like shape can be derived from the normal Acridid type if the bridge would expand and fuse with the lateral pieces, a process some suggestions of which can be seen in several members of the Cryptosacci figured by Roberts himself (*loc. cit.* : figs. 57, 73). The presence on the epiphallus of PAMPHAGINAE of two patches of spines has also been stressed by Roberts as an exclusive feature. However, very detailed description and figures of the epiphallus in *Locusta migratoria* by Boldyrev (1929, *Rep. appl. Entom.* 4 : 196, fig. 5) show the presence of roughly sculptured, strongly chitinised, swellings on the inner portions of the expanded lophi, in a position well corresponding to the spinulose areas in PAMPHAGINAE. Therefore, the shape and the armature of the epiphallus may be useful as a diagnostic feature, but there is no evidence that this type of epiphallus is more advanced than the usual Acridid type.

To sum up, the evidence from the inner genitalia of both sexes gives very dubious support to Roberts' conclusion that the Chasmosacci, and the PAMPHAGINAE in particular, are more primitive phylogenetically than the rest of the ACRIDIDAE. On the contrary, this evidence is in agreement with the tendency

to retrogression observed in various other features of the external morphology of the PAMPHAGINAE.

Venation. The hind-wings of PAMPHAGINAE supply no characters of value for our present purpose. The venation of the elytra (p. 15) agrees best with that found in the subfamily CATANTOPINAE, and must be considered relatively primitive (apart from the specialisation in Porthetini).

Vertex. As has been fully discussed above (p. 14), the vertex even in the group Thrinchini is subject to considerable variation, and still greater diversity will be found when the whole subfamily PAMPHAGINAE is considered. One definite feature of the fastigium of the Pamphagine vertex has recently been stressed by Rehn (1938, *Proc. Acad. nat. Sci. Philadelphia* **90** : 130), namely "a definite break cephalad in the fastigial margins, where the frontal costa passes dorsad without interruption into the scutellum of the fastigium, severing the margins which briefly laterad of this point are definitely carinate." Translated into ordinary language, this means that the sulcus of the frontal ridge is continued on the fastigium, cutting its apex (figs. 7, 8). This is certainly a fairly good diagnostic feature of PAMPHAGINAE (and PYRGOMORPHINAE), but according to my observations (recorded by Rehn, *loc. cit.*), the apical sulcus may disappear, the lateral fastigial carinae becoming fused at the apex. Although a rare individual occurrence, this suggests that there is no fundamental difference between the sulcate fastigial apex of PAMPHAGINAE and the type of fastigium found in many Catantopine genera. Rehn (*loc. cit.*) has particularly insisted on the absence of the apical sulcus in the group Romaleini, but the fact is that in some genera of that group the frontal sulcus is unquestionably continuous with the concave fastigium, the margins of which are not fused apically. As examples, the genera *Chromacris*, *Aeolacris* and *Callonotacris* may be quoted. The latter has been described by Rehn himself (1909, *Proc. U.S. nat. Mus.* **36** : 128) and his figures (*loc. cit.*, figs. 17, 18) are in open contradiction to his latest statement.

Sternum. The presence and the degree of development of the prosternal tubercle in the PAMPHAGINAE are very variable. The same is observed in CATANTOPINAE, a subfamily mainly based on this character, which is now commonly agreed to have little value for the classification of the major groups of ACRIDIDAE. The inflexion of the mesosternal suture described for Thrinchini (p. 11) is common to PAMPHAGINAE in general, and is probably of fundamental value, but it is often weakly expressed and then difficult to appreciate.

Hind femur. As already described (p. 17), a modification in the structure of the femoral base and a reduction of the fish-bone pattern are characteristic of PAMPHAGINAE (and of PYRGOMORPHINAE). This is probably connected with climbing habits and the loss of jumping power, and an adaptation of this kind can hardly be an exclusive feature of the two subfamilies. In fact, in some genera of the group Romaleini, *e.g.*, *Aeolacris* (fig. 54) the fish-bone pattern is irregular to the same extent as in PAMPHAGINAE, while the structure of the femoral base can be regarded as intermediate between the normal Acridid type (fig. 53) and that observed in PAMPHAGINAE (figs. 47–52). The retrogressive character of this specialisation needs no stressing.

Tympanal organ. Studies by Knetsch (1939, *Arch. Naturgesch.* (n.f.) **8** : 26, 31) have indicated that the sensory apparatus in the tympanum of PAMPHAGINAE, including Thrinchini, is not merely of simpler structure, but shows signs of retrogression from the normal Acridid type. In this respect, PYRGOMORPHINAE show even greater reduction than PAMPHAGINAE.

Chromosome number. The normal number of chromosomes in ACRIDIDAE

is now known to be 23 in the diploid male, but studies on PAMPHAGINAE (Powers 1942, *J. Morph.* **71** : 555) and PYRGOMORPHINAE (Rau 1937, *J. Morph.* **61** : 223) have shown the presence of only 19 chromosomes. A tendency to the reduction in the chromosome number, by the formation of multiples, from 23 to 19 and less is observed in various unrelated groups of ACRIDIDAE (McClung 1932, *Actas Congr. intern. Biol. Montevideo* **7** : 1831; Helwig 1941, *J. Morph.* **69** : 317), while cases of an increase in the number are also known. Unfortunately, cytologists have not yet been able to form an independent opinion as to whether the smaller, or the greater, chromosome number in ACRIDIDAE should be considered more primitive. The latest view (Powers, *tom. cit.* : 569), that 19 is the primitive number and that " evolution within the ACRIDIDAE has been accompanied by an increase in chromosome numbers " is based on an uncritical acceptance of Roberts' phylogenetic scheme and, therefore, has little value in itself.

Krauss's organ. This organ (p. 11) is very characteristic of all PAMPHAGINAE and tends to disappear only in some Palaearctic genera that are clearly degraded in many respects, particularly in the complete loss of elytra, wings and tympanal organ. Rehn (1938, *Proc. Acad. nat. Sci. Philadelphia* **90** : 127) has attempted to minimise the importance of Krauss's organ as a character of the subfamily PAMPHAGINAE. According to him, " in many genera of several subfamilies of ACRIDIDAE, we find various stages of development of specialised areas laterad on the second abdominal tergite. They may be merely deeply punctate, irregularly rugulose or regularly striate, sharply defined as a special plate by a margining sulcus or not differentiated from the general tergal surface except by greater or lesser elevation." He then quotes the following genera in which " various degrees of specialised differentiation of the ventrolateral portions of the second abdominal tergite are found," namely, *Eucoptacra*, *Teratodes*, *Pycnosarcus* and *Pezotettix* of the subfamily CATANTOPINAE; *Spathalium*, *Graea* and *Ommexycha* of the OMMEXYCHINAE; and *Chirindites*, *Monistria* and *Rubellia* of the PYRGOMORPHINAE. I have carefully re-examined representatives of all these genera and found that in some of them (and in many others) slight and irregular rugosities or punctures can be discerned on the lower anterior angle of the second tergite, but in no case is there any definite delimitation of this area, nor does its surface represent anything but the direct continuation of the tergal integument. It is obviously impossible to regard mere superficial punctures, or rugosities, on the otherwise undifferentiated integument as in any way analogous to the complicated Krauss's organ described above (p. 11). Equally unfounded is Rehn's statement (*loc. cit.* : 127) that the majority of forms in which such structures occur are " geophilous types and usually, but not invariably, inhabit semi-arid districts or are xerophilous in habits," as well as his suggestion that these structures arise " possibly as responses to habits of life and the rôle which stridulating ability plays in the life history and survival of many, often flightless, acridids " (*loc. cit.* : 128). I have shown (p. 12) that even Krauss's organ is structurally unsuitable for sound-production, and indefinite *punctured* tergal areas cannot be imagined even as stridulating organs. As for the hypothetical survival value of Krauss's organ to flightless ACRIDIDAE, it should be pointed out that most members of the large tribe Porthetini are not flightless, at least in the male sex, and the genera *Thrinchus*, *Utubius*, *Strumiger*, *Tuarega*, etc., are excellent fliers, but they all possess Krauss's organ. On the other hand, partial, or complete, loss of Krauss's organ in PAMPHAGINAE is invariably associated with the complete loss of flight organs, contrary to Rehn's theory. His ecological arguments are also unconvincing,

since amongst the non-Pamphagine genera quoted by him (see above) several are anything but xerophilous in habits. Thus, *Eucoptacra praemorsa* St. " is a thamnophilous species, dwelling in dense patches of grass and bushes bordering paths and streams " in China (Tinkham 1940, *Lingnan Sci. J.* **19** : 331); *Chirindites* occurs in the tropical rain-forest on Mt. Chirinda in S. Rhodesia; *Pezotettix* is not a geophilous form, but a climber on shrubs in Mediterranean countries; and *Teratodes* is a forest form like its close relative, *Pelecinotus*, found in Ceylon " on jungle undergrowth " (Henry 1933, *Ceylon J. Sci.* (B), **17** : 197). There is no reliable information on the habits of the other genera, but it is noteworthy that most of them have well-developed tarsal arolia, an evidence of climbing, and not of geophilous, habits. Therefore, the whole argument of Rehn falls to the ground, being based on a failure to appreciate the true structure of Krauss's organ, on his non-critical acceptance of previous erroneous views concerning its function, and on an unfounded hypothesis of its survival value. Thus, Krauss's organ remains of outstanding importance for the characterisation of PAMPHAGINAE, since it supplies the only *positive* distinction between this subfamily and the rest of ACRIDIDAE. In this connection, however, it is necessary to discuss some extra-Palaearctic Acridid genera which possess Krauss's organ, but the affinity of which with PAMPHAGINAE has been disputed.

Genera of intermediate position. There are five genera definitely known to possess Krauss's organ, but otherwise somewhat divergent from other PAMPHAGINAE. They are *Phrynotettix* Uhler 1872, *Dracotettix* Bruner 1889 and *Litoscirtus* Bruner 1907 in south-western North America and Mexico; *Aucacris* Hebard 1929 in Chile; and *Buforania* Sjöstedt 1920 in Australia. One of them (*Dracotettix*) has been definitely referred by me to PAMPHAGINAE (Uvarov 1938, *Pan-Pacific Entom.* **13** : 97), but this view has been strongly opposed by Rehn (1938, *Proc. Acad. nat. Sci. Philadelphia* **90** : 123 ff.), who maintained that both this genus and the related *Litoscirtus* (not known to me by specimens) should be regarded as CATANTOPINAE of the group Tropinoti (now Romaleini). In support of this view, twelve morphological points were advanced, but seven of them may be summarily dismissed, since, according to Rehn himself, no conclusive evidence in favour of either view can be obtained from the following structures : antennae (Rehn's point 2), frontal ridge (3), general shape of fastigium (4), fastigial margins (5), pronotal carina (6), prosternal tubercle (7), male abdomen (11). One of the remaining points, the presence of the fastigial sulcus (Rehn, *loc. cit.* : 130; a point without number), has been fully discussed above (p. 25) and found of no value for our problem. Rehn's point 10 refers to a feature not yet discussed in the present paper, namely the spines of the hind tibiae. In the PAMPHAGINAE the spines of the inner series are usually only a little longer than those of the outer and are weakly incurved, while in the group Romaleini " the internal spines are very markedly longer than the external series and in addition they are characteristically formed, their apices being extremely aciculate on a concavely conical base. Further, the whole spine is usually in-bowed towards the median line of the tibia " (Rehn, *loc. cit.* : 128). According to Rehn, the tibial armature in *Dracotettix* and *Litoscirtus* " is closer to what occurs in the group Tropinoti than the type present in the PAMPHAGINAE." This is a mere expression of personal opinion and the purely relative value of this character underlines its lack of phylogenetic significance. Moreover, this kind of specialisation in the armature of the hind tibiae is not restricted to Romaleini, and identical, or closely similar, development of the spines can be seen in such entirely unrelated genera as *Acanthacris* (especially in *A. ruficornis citrina* Serv.), *Abisares* and *Dericorys* of the CATANTOPINAE, *Desmoptera* of the

Pyrgomorphinae and even in some Eumastacidae. All these insects live on trees and shrubs and the modification of hind tibial spines may possibly be connected with climbing habits. Nor is it correct to say that this modification is typical for the whole group Romaleini, since at least in some species of the genus *Xyleus* (e.g. *X. laevipes* St., cf. Bruner 1900, *Rep. Merch. Locust Invest. Comm.* **2** : 57) the tibial spines are not more specialised than in many true Pamphaginae. Thus, the armature of hind tibiae cannot be regarded as excluding *Dracotettix* and *Litoscirtus* from Pamphaginae.

The point 9 in Rehn's list refers to the structure of the hind femur. The relative value of this character has already been discussed (p. 17), but it must be admitted that the femur of *Dracotettix* shows practically no sign of the retrogressive adaptation characteristic of other Pamphaginae. Thus, it may be possible to regard this character, at least, as an indication of the closer relationship of *Dracotettix* to Catantopinae.

Finally, one comes to Krauss's organ (Rehn's point 8). Rehn's attempt to dispose of this proof of Pamphagine affinities of *Dracotettix* has been discussed above (p. 26) and its definite positive value established.

Further evidence relevant to this discussion has been introduced by studies of the internal genitalia. The spermatheca of *Dracotettix* has a single recurved diverticulum, as found in Pamphaginae but not in Romaleini. On the other hand, the glandular pouches are present, although they are absent in Pamphaginae (Slifer 1940, *J. Morph.* **66** : 178; **67** : 207); the loss of glandular pouches, however, is known to occur, without reference to taxonomic position, in some Romaleini and in other Catantopinae.

The male genitalia of *Dracotettix* have been found by Roberts (1941, *Proc. Acad. nat. Sci. Philadelphia* **93** : 239, figs. 48, 52) to agree with the Romaleini and not with Pamphaginae.

One sees, therefore, that *Dracotettix* occupies a clearly intermediate position between Catantopinae (Romaleini in particular) and Pamphaginae, and its formal inclusion into one, or the other, subfamily would be largely a matter of personal opinion. It may be regarded either as a Pamphagine, with Krauss's organ and the recurved diverticulum of the spermatheca, while still preserving the normal femur, glandular pouches and male genitalia of Catantopinae; or as a Catantopine which has acquired the two Pamphagine characters. Since the Pamphagine characters, particularly Krauss's organ, are positive acquisitions, while the Catantopine ones are merely conservative, I think it would be more correct, and certainly better for taxonomic practice, to include *Dracotettix* in the Pamphaginae. The same conclusion would apply to *Litoscirtus*, which is unknown to me, but which, according to Rehn (*loc. cit.*), is closely related to *Dracotettix*.

The third North American genus in this group is *Phrynotettix*. Its relation to *Dracotettix* is more or less the same as that of a brachypterous member of Thrinchini to one of the true Pamphaginae, the essential feature of *Phrynotettix* being a depressed body and a broad, obtuse vertex. The spermatheca in *Phrynotettix* has no apical diverticulum, and glandular pouches are absent, so that "the position of *Phrynotettix* as a member of the Romaleinae is open to question" (Slifer 1943, *J. Morph.* **72** : 227). Otherwise, our discussion of *Dracotettix* in relation to Pamphaginae can be applied equally well to *Phrynotettix*. It should be pointed out that the chromosome complex in this genus has been determined as 23, *i.e.*, normal for Acrididae, but this merely adds one more conservative character and does not affect the positive significance of Krauss's organ, which is well developed in *Phrynotettix*.

The Chilean genus *Aucacris* appears to be close to *Phrynotettix*, although Roberts (1941, *loc. cit.* : 239) has stated that it does not belong to Romaleini, apparently only on the basis of the male genitalia. It has a well-formed Krauss's organ, and I see no reason for not including it in PAMPHAGINAE, together with *Phrynotettix*.

The Australian *Buforania*, while sharing other characters, including Krauss's organ, with the above genera, differs from them in the absence of the external apical spine of hind tibia. The phylogenetic value of this loss of the spine has been discussed (p. 19), and it cannot be regarded as of great importance.

There is, therefore, a group of genera referable to PAMPHAGINAE by the presence of Krauss's organ, but preserving the normal hind femur and some other characters of CATANTOPINAE. The existence of such genera, clearly transitional between subfamilies, is not surprising and merely corroborates the present view that ACRIDIDAE constitute a single family, which can be subdivided only into several, imperfectly delimited, subfamilies. From the formal taxonomic point of view the five genera just discussed may be regarded as a tribe of the subfamily PAMPHAGINAE, which it is proposed to call **Phrynotettigini** tribe n., from the oldest genus, *Phrynotettix* Glover.

SUBFAMILIES OF ACRIDIDAE.—In entering upon the discussion of the interrelations of Acridid subfamilies, Roberts (1941, *loc. cit.* : 231) points out an important source of error in similar discussions, namely that "the loss or suppression of a structure is a relatively frequent and simple occurrence in contrast to the development of a new type or form of structure. Thus, the presence of a structure may be quite significant, but its absence should be treated as entirely negative. . . ." It is most unfortunate that this very sound caution has not been heeded by the author. I have shown (p. 23) that even in the morphology of the copulatory apparatus, which served as the main basis for the subfamily classification proposed by Roberts, the available evidence tends to show that the group of Chasmosacci is not more primitive than, but very probably derived from, the Cryptosacci by the processes of loss, simplification or reduction, of various parts. The phallic structures of the Cryptosacci are common to all ACRIDIDAE, except the two subfamilies of the Chasmosacci, PAMPHAGINAE and PYRGOMORPHINAE, which show various clear signs of retrogression and few of progressive specialisation. Therefore, it is the Cryptosacci group of subfamilies that is the more generalised and, consequently, the one that is probably ancestral to all ACRIDIDAE.

Among the Cryptosacci the subfamily CATANTOPINAE has the simplest elytral venation, and I fully endorse the opinion of Zeuner (1941, *Ann. Mag. nat. Hist.* (11) **8** : 511), who has called CATANTOPINAE "the least specialised ACRIDIDAE." It is true, as Roberts (*loc. cit.* : 237) has pointed out, that this is a very heterogeneous assemblage, which may prove to include more than a single subfamily. Since, however, it is also very large and little studied, all attempts to split off from it smaller groups and call them subfamilies, should be discouraged unless the whole group is revised. Such an action has been taken by Roberts (*loc. cit.*) in proposing the new subfamily ROMALEINAE. This subfamily has been based solely on the genital characters, which are mainly retrogressive and transitional between those of CATANTOPINAE and of PAMPHAGINAE (p. 24). Their value is further reduced by the fact that the respective organs of CATANTOPINAE in general have received very little attention (Roberts, *loc. cit.* : 222). No characters in the external morphology, or in the anatomy of other organs, have been given to justify the separation of ROMALEINAE from CATANTOPINAE, and, if they exist, their value as subfamily characters

remains to be substantiated. Further, no attempt appears to have been made to investigate whether any genera of the Old World might be referable to Romaleinae, and the subfamily has been erected to accommodate a number of New World genera of very diverse appearance. I propose, therefore, to reduce the subfamily Romaleinae to its former status of a group, probably a tribe, within the subfamily Catantopinae.

The development of Pamphaginae and Pyrgomorphinae from Catantopinae, as already discussed (p. 22), was due entirely to retrogression in some respects and to considerable secondary specialisation in others. Their affinity with the more primitive Catantopinae is supported by the elytral venation, particularly by the normally open discoidal area, which is normally closed in all Oedipodinae and Acridinae (and, less regularly, in the higher Catantopinae, *e.g.*, in the groups Calliptamini and Cyrtacanthacridini). As a subfamily, Pamphaginae are, of course, best characterised by the presence of Krauss's organ and the shape of the epiphallus, which serve to distinguish them from the Pyrgomorphinae. Their connection with the Catantopinae through Phrynotettigini has been discussed (p. 27).

The subfamily Ommexechinae is still very little known, but very aberrant in many respects. Its chromosome number (23) is normal for Acrididae, copulatory organs of both male and female are very distinctive, and the elytral venation is of the relatively simple, Catantopine type. The hind femur in some genera shows partial retrogression, the base being normal, but the fish-bone pattern distorted. The subfamily can be regarded as an offshoot from some early Catantopines, and less retrogressive than Pamphaginae and Pyrgomorphinae.

The subfamily Pauliniinae is also insufficiently studied, but appears to differ from Catantopinae only in a few features of specialisation, which are probably of quite secondary value.

The remaining two subfamilies, Acridinae and Oedipodinae, are very close to each other, but are distinguished by the stridulatory specialisation of the elytra and of the hind femur (Uvarov, 1942, *Trans. Amer. ent. Soc.* **67 :** 336). In Oedipodinae there is always a strongly raised (and sometimes serrate) discoidal vein, while the other part of the mechanism is represented by an acute ridge on the inner face of the hind femur. In Acridinae there is no discoidal vein, or it is very irregular and not used for stridulation; instead, the second radial vein (*radialis media* of Brunner; *radius* of Snodgrass) is sharply raised and the hind femur bears a series of stridulatory pegs on its inner face.[3] This difference is so definite that one fails to understand Roberts' statement (*loc. cit.* : 238) that " no satisfactory means of distinguishing the Acridinae from the Oedipodinae has been found," unless it refers to the lack of difference in their copulatory organs alone, the importance of which has been unduly over-rated by Roberts.

The relation of Acridinae and Oedipodinae to the Catantopinae is one of higher specialisation. This is expressed in the permanent loss of the prosternal tubercle (present only in a rudimentary state in a few genera) and of the external distal spine of the hind tibia, as well as in the normally closed discoidal area of the elytra. The divergence of Acridinae from Oedipodinae is due to a subsequent stridulatory specialisation in two different directions.

[3] Some groups now referred to Acridinae (*e.g.*, Duroniae, Phlaeobae etc.) have no stridulatory mechanism of this kind, but the absence of a regular discoidal vein distinguishes them from Oedipodinae. Further studies are necessary to decide whether the present subfamily Acridinae will have to be divided in two, or more, subfamilies, on the basis of this character.

I am, thus, able to represent the evolutionary interrelations of Acridid subfamilies in a phylogenetic scheme (fig. 56). The scheme should be regarded as a tentative one, and may require considerable further elaboration, but I believe it to be true in its main features, which are (1) the progressive trend of the ACRIDINAE–OEDIPODINAE stock and (2) the retrogression, masked by secondary specialisation, in the evolution of the PAMPHAGINAE–PYRGOMORPHINAE.

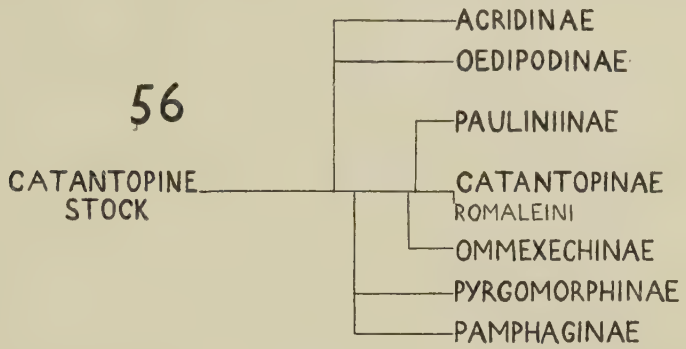


FIG. 56.—Phylogenetic relationship of subfamilies of ACRIDIDAE.

GEOGRAPHICAL DISTRIBUTION.

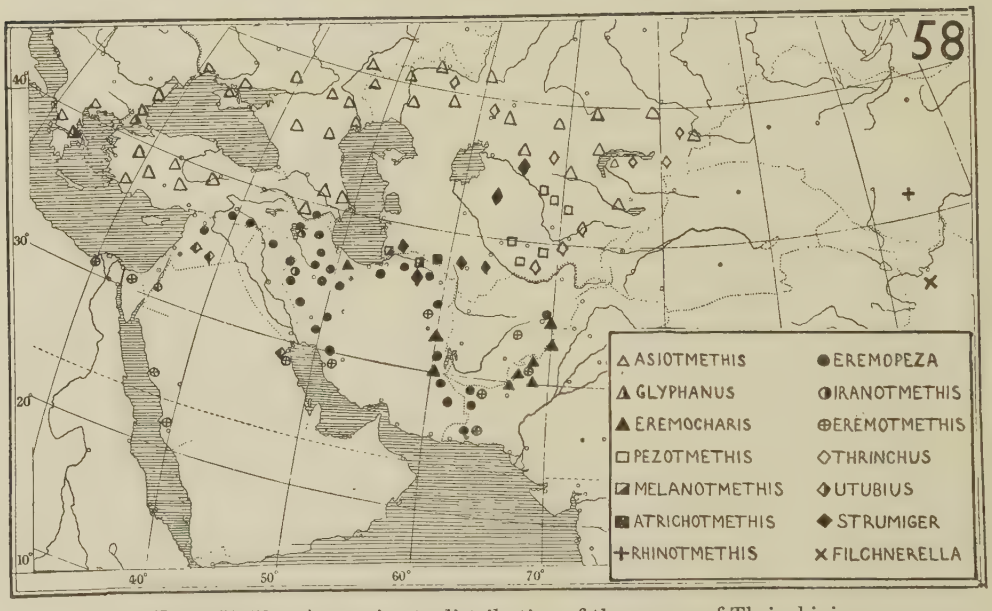
Our present knowledge of the distribution of the Palaearctic Thrinchini is still far from satisfactory and only a few general considerations can be offered.

A glance at the maps (figs. 57, 58) might suggest that the Thrinchini have a predominantly Mediterranean distribution, taking this term in its widest sense. This impression, however, proves to be erroneous, if a closer analysis is applied. The distribution of *Prionotropis*, for example, might appear Mediterranean, but the fact is that all its representatives, while occurring within the general geographical limits of the Mediterranean region, are definitely excluded from the coastal areas with a pure Mediterranean climate, and are restricted to more or less isolated areas characterised by semi-desert conditions of climate and vegetation. Similarly, the genus *Tmethis* in North Africa is restricted to the Hautes Plateaux of Morocco and Algeria with semi-desert conditions and fails to reach the Algerian coast; in Tunisia, Cyrenaica and Egypt it is found on the coast, but only because there the conditions are far from being typically Mediterranean. In Palestine, Syria and Iraq, the distribution of *Tmethis* follows the lower altitudes of the great mountainous arc skirting the Arabian desert from the west, north and east, and if in Palestine *T. pulchripennis asiaticus* penetrates to the coast, this again is a reflection of local ecological conditions. The same applies to the distribution of *Asiotmethis* and *Glyphanus* in Asia Minor, the Balkan Peninsula and the Caucasus, where typically Mediterranean areas, with a mild wet winter and evergreen vegetation, are definitely avoided.

Thus, Thrinchini, as a group, are definitely not Mediterranean, but they cannot be called an Eremian group, either. Indeed, there is only one genus in North Africa, *Tuarega*, which is definitely Eremian in its distribution. In Asia, the genera *Utubius* and *Strumiger* are also restricted to typical Eremian habitats, but *Thrinchus* is mainly connected with semi-desert areas.

The remaining majority of the genera occupy an interesting intermediate position between the Eremian and the Mediterranean types of distribution,

being, on the whole, restricted to barren foothills of mountains fringing the desert areas. This biogeographic character of Thrinchini supports the derivation of the group from a common root with Pamphagini (see p. 21) as a result of progressive dessication and of transition from phytophilous (climbing) habits to geophilous. From the distributional point of view, the same bio-



Figs. 57, 58.—Approximate distribution of the genera of Thrinchini.

geographic character, coupled with a tendency to flightlessness, is the cause of strong localisation of subspecies, species and genera, which leads to a complicated taxonomy. That the specific and subspecific differentiation in Thrinchini is closely bound up with spatial and ecological isolation, should be abundantly clear from the lists under the different genera, but the genera themselves are, in most cases, also limited geographically. Thus, *Eremopeza* (and its offshoot, *Iranotmethis*) is clearly restricted to the Iranian mountain systems; *Eremocharis*

to those of Baluchistan (with but one somewhat aberrant species in N.W. Iran); *Eremotmethis* occurs along the fringing hills of Arabia, continuing into southern Iran and Baluchistan; *Tmethis* is essentially a North African genus, though extending its range into Western Asia; *Pezotmethis* is restricted to the low hills of Russian Middle Asia; while *Melanotmethis*, *Atrichotmethis*, *Rhinotmethis* and *Filchnerella* are mostly monotypic genera with a very narrow range.

A much wider range of distribution coupled with a lack of local differentiation is seen in the case of *Tuarega*, owing to its purely deserticolous habits and exceptional powers of flight, but it is a curious fact that the only known species, *T. insignis*, has not spread east of the gulf of Suez. As a genus, *Asiotmethis* also populates a very wide area of the Aralo-Caspian semi-deserts, penetrating westwards to the inner plateau of Asia Minor (where there is a very pronounced admixture of the Aralo-Caspian faunistic elements; see Uvarov, 1934, *Eos* **10 :** 37), and to the southern Balkan Peninsula (where *Glyphanus* represents its narrowly localised offshoot). This area of *Asiotmethis* coincides largely with the semi-deserts with loess soil, but it is a noteworthy fact that, in spite of the apparent uniformity of this type of habitat, the distribution of *Asiotmethis* is markedly discontinuous, the colonies being found only in the driest and warmest situations, such as chalk outcrops, gravelly hills, dry salt-pans etc. The inevitable result is a tendency to differentiation of local species and subspecies. An excellent example of such localisation is offered by the existence of at least seven subspecies of *Asiotmethis heldreichi* on the plateau of Asia Minor (Uvarov 1934, *Eos* **10 :** 38, 109, *Tmethis heldreichi*).

Taken as a whole, the tribe Thrinchini offers exceptional opportunities for studies in taxonomic differentiation connected with ecological and geographical isolation.

Intraspecific Variation.

The extreme variability, in e.g. *Tmethis* spp., is well known to taxonomists and their usual attitude to it is to dismiss all " minor " variations as purely individual. More recent work tends to show, however, that the following types of intraspecific variation are met with in the group.

1. *Continuous geographical variation.* One of the best examples is offered by *Eremopeza gibbera*. The species populates an arch-shaped zone of low dry mountains stretching from Syria eastwards through northern Iraq and then southwards along the borders of Iraq and Iran, down almost to the Persian Gulf. In the extreme north-west, *i.e.* in Syria, the species is represented by subsp. *gibbera* with the black wing fascia covering the whole basal part of the wing; in northern Iraq, the fascia remains broad, but the disc of the wing is blue (subsp. *lata*); farther south, the width of the fascia decreases, and the disc tends to become greenish-blue (subsp. *angusta* from the borders of Central Iraq and Iran); still farther south, in the mountains of S.W. Iran, the subsp. *reducta* occurs, characterised by the light sulphur-yellow wings with a very narrow fascia (see Uvarov 1934, *Eos* **10 :** 103–106). The two extreme races are strikingly different, but even the present incomplete series show that the transition is gradual and the variation quite continuous.[4] The division into subspecies is,

[4] This type of subspecific variation has been given the name of " cline " by Huxley (1942, *Evolution* : 206). The term covers a complete series of geographically continuous subspecies, and its application to taxonomic practice would lead to a most cumbersome nomenclature. Thus, the *Eremopeza* just quoted would have to be called *Eremopeza gibbera* cline *gibbera-reducta*, and in the case of specimens from an intermediate locality, the stage in the cline should be further indicated by an agreed numeral, or a letter. Thus, the present

therefore, an admittedly artificial one, but the alternative would be to regard *E. gibbera* as an extremely variable species, thus masking the important fact that this variation is strictly correlated with geographical distribution. The present arbitrary division into four subspecies makes it possible to record their distribution, which may be of value for the future analysis of the factors responsible for this type of variation.

Similar continuous variation appears to exist in *Eremopeza cinerascens*, and probably in some species of *Tmethis* (cf. Vosseler, 1902, *Zool. Jahrb., Syst.* **16 :** 384; **17 :** plate 3).

2. *Discontinuous geographical variation.* Most species of Thrinchini are restricted ecologically, and this leads to discontinuity of geographical distribution, the specific area usually being composed of more or less numerous, and more or less isolated, populations. The result of the isolation is often sufficiently pronounced for the recognition of distinct subspecies, each inhabiting a relatively restricted area. This type of subspecific variation is particularly well shown in the genera *Tmethis*, *Asiotmethis* and *Eremocharis*, and an excellent example is offered by *Asiotmethis heldreichi*, which forms no fewer than seven subspecies in Anatolia and Greece (see p. 55; also Uvarov 1934, *Eos* **10 :** 38, 109–111). The subspecies of this kind almost certainly represent the second stage in the subspecific differentiation, the first being continuous geographical variation discussed above, while the next stage would be a full specific differentiation of the populations that remain in isolation for a sufficiently long period. In many cases it will, therefore, be difficult to distinguish between independent species and discontinuous subspecies. Thus, the three discontinuous subspecies of *Prionotropis hystrix* (see p. 40) may with almost equal right be regarded as distinct species.

3. *Ecological forms.* The fact that the individuals of Thrinchini usually exhibit a general coloration remarkably similar to the colour of the ground on which they live has been often commented upon (see particularly Vosseler 1902, *loc. cit.*). This is probably due to the individual adjustment of pigmentation to the colour of the background during the nymphal development, a phenomenon experimentally proved to exist in other Acrididae by Faure (1932, *Bull. ent. Res.* **23 :** 293–424). The possibility of some types of pigmentation being inheritable cannot be excluded *a priori*, and experimental studies on some easily obtainable species would be of great general interest.

It should be also pointed out that the " imitation " of the ground sometimes goes further than the mere general tone of coloration, since indefinite dark spotting may develop in apparent agreement with a spotted (*e.g.*, pebbly) ground. Moreover, the sculpturing of the exposed parts (particularly pronotum) appears also to bear some relation to the surface of the ground; thus, very lightly coloured, almost white, forms of *Asiotmethis* and *Tmethis* found on smooth salt-pans have the integument almost devoid of the usual tubercles. Here is another problem for most interesting experimental studies, which alone can decide whether this kind of variation is purely individual (phenotypic) or

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trinomial designation of a subspecies would become quinquenomial; in cases when " clines " for different characters run in different directions (cf. Huxley, *loc. cit.* : 226), a further set of names would have to be added, and the terminal names of each of the " character clines " will often be different. The confusion that would arise as a consequence of synonymy can be easily imagined. The evolutionary phenomenon now termed " cline " is well known to taxonomists, but attempts to introduce the conception into taxonomic practice should not be made with complete disregard for the nomenclatural confusion that would follow.

inheritable (genotypic); in the latter case it may fall under the category 5 discussed below.

4. *Homologous colour variation.* Since in Thrinchini the colour is only weakly differentiated into a definite pattern (see p. 3), it is not surprising that the phenomenon of homologous colour forms, well known in higher subfamilies of Acrididae (Vorontsovskii 1928, *Izvest. Orenburg. Sta. Plant Prot.* **1** : 27; Rubtzov 1935, *Bull. ent. Res.* **26** : 499), is of very limited occurrence in Thrinchini. Still, there are several pattern forms that may come into this category, as the following examples will show :—

(*a*) In several species of *Asiotmethis*, *Tmethis* and *Glyphanus*, a form exists characterised by narrow light-yellow margination of pronotum. It has been described as var. *flavolimbus* of *A. muricatus* by Vorontsovskii (*loc. cit.* : 21), where both the anterior and the posterior margins are yellow, while more frequently this colour appears only along the posterior margin. The term *flavolimba*, without author's name, may conveniently be used to designate this colour form in any species.

(*b*) Dark round spots on elytra separated by light intervals are often developed in various species of *Asiotmethis* and *Tmethis*, apparently without respect to the taxonomic units, or to ecological conditions, and these spotted forms may well represent a case of homologous colour variation in the sense of Vavilov (1922, *J. Genetics* **12** : 47).

5. *Variation in the sculpturing of integument.* As pointed out above (see paragraph 4), the relative roughness of the integument may be correlated with the environment, but the occurrence of roughly sculptured individuals side by side with the almost smooth ones suggests the possibility of this character being in the category of genotypic homologous variation. Relatively smooth forms are known in many species which normally have strongly rugose integument; in one case, that of *Tmethis cisti clavelii*, the name var. *laeviuscula* Krauss has been proposed, and *laeviuscula* (without author's name) may conveniently be used to designate smooth forms in any species.

Another kind of morphological variation is presented by the forms with high-crested (fig. 61) and low-crested (fig. 63) pronotum, especially in the genus *Tmethis*. Such strikingly different forms are known to occur in the same locality, and the difference is often so considerable that it might be mistaken for specific; in the case of *Tmethis* the existence of such forms was the cause of great taxonomic confusion. The low-crested form has been given the name var. *incristata*, in the case of *T. maroccanus* I. Bolivar, and this term, without author's name, may conveniently be applied to this form of any species.

It appears that f. *incristata* may often be also f. *laeviuscula*, but until the correlation is definitely established, it would be better to distinguish them. The true character of these forms, *i.e.*, their relation to the environment during the individual development, and their inheritability present most interesting problems to be studied by exact field observations (extended to the earliest larval stages) and by detailed breeding experiments.

KEY TO GENERA.

1(12). Pronotal carina in profile regularly arched throughout (figs. 18, 19, 23), or practically straight (fig. 17); in both cases it is only narrowly interrupted by the typical sulcus.

2 (9). Pronotal profile arched; metazona transversely convex (figs. 18, 19, 23). Frontal ridge sulcate.

3 (4). Pronotal carina laminate; typical sulcus very narrow (fig. 23). Vertex (figs. 2, 10) very broad, with thick callous carinae; supraocellar foveola large; preocellar foveola small. Frontal ridge very broad, with a transverse carina above the ocellus. Hind-wings diffusedly infumate . . . . . *Prionotropis* (p. 38).

4 (3). Pronotal carina thick; typical sulcus broad (figs. 18, 19). Vertex (figs. 4, 12) somewhat inflated, with the carinae almost, or quite, obsolete; foveolae weak, irregular, or obsolete. Hind-wings usually brightly coloured, provided with a definite dark fascia which may expand so that the whole wing is black with a light fascia.

5 (6). Hind femur slender, its carinae not laminate (fig. 47). Always fully macropterous; hind-wings brightly coloured, with a black fascia and black apical spot . . . . . *Eremopeza* (p. 41).

6 (5). Hind femur broad, its carinae laminate.

7 (8). Pronotum strongly gibbose (similar to fig. 19); metazona acutangular. Vertex with weak, but distinct foveolae. Elytra strongly coriaceous, abbreviated, particularly in the female; axillary veins of the hind-wing strongly sinuate; wing blue, with a broad dark fascia **Iranotmethis** gen. n. (p. 45).

8 (7). Pronotum less gibbose; its carina more broadly interrupted by the typical sulcus; metazona parabolic. Vertex without foveolae. Elytra submembranous, fully developed in both sexes; axillary veins of the hind-wing weakly sinuate; wing faintly greenish, with a narrow fascia, often dissolved into spots **Eremotmethis** gen. n. (p. 46).

9 (2). Pronotal profile straight; metazona flat (fig. 17). Vertex with obsolete foveolae (figs. 15, 16). Frontal ridge not sulcate. Wings with a distinct, more or less disrupted, dark fascia, but without the apical spot.

10(11). No pronotal carina, even in the prozona, which is rounded transversely; metazona large, flat, parabolic, with thin edge. Elytra very long, reaching the apex of hind tibia. Vertex narrow; frontal ridge broad (fig. 15) . . . . . **Tuarega** gen. n. (p. 47).

11(10). Prozona transversely gibbose, with a low but thick carina, which is finely sulcate; metazona large, almost flat, or even somewhat concave, angulate behind, with thick edge. Vertex broad; frontal ridge narrow (fig. 16). Elytra of varying length, sometimes strongly abbreviated . . . . . *Eremocharis* (p. 47).

12 (1). Pronotum more or less saddle-shaped; its carina viewed in profile is strongly raised in prozona, but descends abruptly at the typical sulcus, always quite low in the anterior portion of metazona, but may become fairly high again posteriorly (figs. 20, 21, 22).

13(28). Robustly built. Fully winged, or brachypterous; in the former case, elytron never reaching beyond the middle of hind tibia, and its length not more (usually much less) than four times its maximum width. Hind tibia always with terminal spines on both sides.

14(23). Vertex broad, weakly sloping forward; preocellar and supraocellar foveola usually well defined and placed on the same plane as the surface of vertex. Frontal ridge broad (figs. 1, 3, 9, 11).

15(20). Metazona of pronotum rounded, or parabolic; behind, generally thin, or with a distinct laminate edge.

16(19). Metazona parabolic, longer than wide. Elytra fully developed in both sexes, or at least in the male; in the female they may be reduced to broadly oval lateral pads (fig. 43).

17(18). More slenderly built, practically hairless, except for some sparse and short hairs on hind tibia. Fastigium of vertex somewhat inflated;

its foveolae scarcely concave and dividing ridges very weak. Hind femur relatively narrow; its upper carina straight (fig. 49). Posterior edges of abdominal tergites without acutely produced folds. Male cercus long, slender, weakly incurved. Hind-wing with a broad dark fascia which is equally well defined at both margins
Atrichotmethis gen. n. (p. 51).

18(17). More robustly built, with abundant long hairs on the lower edges of the body and particularly on the hind tibia. Fastigium of vertex not inflated; all foveolae concave, separated by strong ridges (figs. 1, 9). Hind femur broad; its upper carina strongly wavy, or dentate, rather suddenly lowered before the knee (fig. 51). Posterior edges of abdominal tergites with acutely produced folds. Male cercus short, narrowly triangular in the lateral view, straight. Hind-wing with a variable fascia, which is usually better defined on the outer margin than on the inner, where it gradually becomes diffused
Asiotmethis gen. n. (p. 52).

19(16). Metazona wider than long, very broadly rounded behind. Elytra in both sexes reduced to narrow lateral pads (fig. 44) *Glyphanus* (p. 58).

20(15). Metazona of pronotum incrassate, without a laminate edge; angular behind, though the angle may be obtuse.

21(22). Elytra in both sexes strongly abbreviated, but not completely lateral, touching each other dorsally. Subtympanal lobe small (as in fig. 29)
Pezotmethis gen. n. (p. 59).

22(21). Elytra in the male normal, in the female somewhat abbreviated (almost reaching hind knees). Subtympanal lobe large (as in fig. 30). Hind-wing black, except the apex . **Melanotmethis** gen. n. (p. 60).

23(14). Vertex narrow, strongly sloping forward, with distinctly raised lateral margin, on which a weakly defined supraocellar foveola is placed; preocellar foveola absent or scarcely indicated. Frontal ridge narrow (figs. 6, 14).

24(25). Metazona of pronotum with laminate edge, longer than prozona. Frontal ridge in profile weakly projecting forward, somewhat depressed but not incised below the antenna (fig. 21). Subtympanal lobe large (fig. 30). Elytra normal, or somewhat abbreviated, but never lateral, even in the female. Hind-wing usually rose, very seldom hyaline, with a more or less diffused dark fascia
Tmethis (p. 61).

25(24). Metazona of pronotum thick, at the most equal to prozona in length, but usually shorter. Frontal ridge in profile, more (fig. 22), or less, projecting forward, incised below the antenna. Subtympanal lobe small (as in fig. 29). Elytra strongly abbreviated, at least in the female. Wings hyaline, with a dark fascia.

26(27). Frontal ridge moderately projecting forward. Both sexes brachypterous . . . . . *Filchnerella* (p. 67).

27(26). Frontal ridge strongly projecting forward (fig. 22). Female brachypterous; male with the elytra somewhat shorter than the body
Rhinotmethis (p. 68).

28(13). Slenderly built. Fully winged; elytron reaching the apex of hind tibia, its length five times its maximum width. Hind tibia lacking at least the external terminal spine.

29(30). Anterior margin of prosternum normal. Frontal ridge in profile not depressed suddenly below the ocellus. Male subgenital plate simple . . . . . *Utubius* (p. 68).

30(29). Anterior margin of pronotum raised like a collar. Frontal ridge in profile suddenly depressed below the ocellus. Male subgenital plate bituberculate apically.

31(32). Prosternal collar not large, does not cover the mouth-parts from below. Lower anterior angle of lateral pronotal lobe normal *Thrinchus* (p. 69).

32(31). Prosternal collar very large, covering mouth-parts from below. Lower anterior angle of lateral pronotal lobe attenuated obliquely forwards, acute . . . . . *Strumiger* (p. 70).

PRIONOTROPIS Fieber 1853.

1853 (June). *Prionotropis* Fieber, *Lotos* **3** : 127.
1853 (November). *Cuculligera* Fischer, *Orth. eur.* : 297, 390.
1882. *Cuculligera* Brunner von Wattenwyl, *Prodr. eur. Orth.* : 177.
1910. *Prionotropis* Kirby, *Syn. Cat. Orth.* **3** : 283.

Genotype : *Gryllus hystrix* Germar 1817, the only species originally included by Fieber.

Diagnosis. See Brunner von Wattenwyl (1882, *loc. cit.*).

Notes. Most of the species of *Prionotropis* are known from meagre material, and the following key is a purely tentative one.

Key to species.

1 (8). Pronotum compressed, its carina sharp, laminate. Metasternal interspace in male little more than twice, in female four times, as broad as long.
2 (5). Male fully winged, female brachypterous.
3 (4). Median spines of abdominal tergites very short, obtuse. Hind tibia yellow to red. Male : wings infumate throughout, with a distinct, though not sharply defined, dark fascia. Female : elytra very short, not projecting behind the posterior pronotal angle 1. *maculinervis*.
4 (3). Median spines of abdominal tergites long, very acute. Hind tibia blue to violet. Male : wings yellowish, without a distinct fascia. Female : elytra about equal in length to pronotum, covering at least two first tergites . . . . . 2. *flexuosa*.
5 (2). Both sexes with more or less abbreviated elytra and wings.
6 (7). Hind femur on the inside mainly blue; hind tibia red. Male : elytra almost reaching the apex of abdomen. Female : elytra reaching the third tergite . . . . . 3. *appulum*.
7 (6). Hind femur on the inside, and hind tibia, yellow. Male : elytra not extending beyond the third tergite. Female : elytra not reaching the third tergite . . . . . 4. *hystrix*.
8 (1). Pronotum robust, gibbose; its carina low, tectiform, not laminate. Metasternal interspace in male three times, in female six times as broad as long. Upper carina of hind femur very weakly, or not at all, denticulate. Inside of hind femur and tibia yellow. Both sexes brachypterous . . . . . 5. *rhodanica*.

1a. *Prionotropis maculinervis maculinervis* (Stål 1878).

1878. *Cuculligera maculinervis* Stål, *Bih. Sven. Akad. Handl.* **4** (5) : 28.
1899. *Cuculligera maculinervis* I. Bolivar, *Ann. Soc. ent. Belg.* **43** : 595.
1932. *Cuculligera maculinervis* Sjöstedt, *Ark. Zool.* **24A** (1) : 24; pl. 5, fig. 8, pl. 6, fig. 1.
1933. *Cuculligera maculinervis* Ramme, *Mitt. zool. Mus. Berlin* **18** : 434; figs. 9, 10, 11.

Notes. The original description was based on the male alone, and the female described later by I. Bolivar from a different locality (Bimbogha Dagh) may possibly belong to another subspecies.

Type locality. Turkey : Amasia.

1b. *Prionotropis maculinervis urfensis* Ramme 1933.

1933. *Prionotropis urfensis* Ramme, *Mitt. zool. Mus. Berlin* **18** : 431, figs. 9, 10, 11; pl. 12, fig. 11.

Notes. The difference from the typical form is mainly in the colour of hind tibia which in *urfensis* is, according to Ramme, " fahl orange statt rötlichgelb bis rot," while morphological differences are small. It appears more correct, therefore, to regard *urfensis* as only a subspecies of *maculinervis*.

Type locality. Turkey : Urfa.

2. *Prionotropis flexuosa* (Serville 1838), fig. 10.

This Spanish species appears to have a number of geographical forms, three of which have been distinguished as " varieties " by I. Bolivar and are listed below, but a study of abundant material from different parts of Spain is necessary to establish their actual number and distribution.

2a. *Prionotropis flexuosa flexuosa* (Serville 1838), figs. 45, 46, 48.

1838. *Eremobia flexuosa* Serville, *Ins. Orth.* : 709.
1904. *Cuculligera flexuosa* var. *azurea* Navas, *Bol. Soc. Aragon.* **3** : 193.
1921. *Prionotropis flexuosa* forma typica I. Bolivar, *R. Soc. esp. Hist. nat.*, **50 anniv.** : 458.

Type locality. Originally described simply from Spain, but I. Bolivar has designated the south of the Teruel province as the type locality.

2b. *Prionotropis flexuosa perezii* (I. Bolivar 1876).

1873. *Thrinchus perezii* I. Bolivar, *An. Soc. esp. Hist. nat.* **2** : 234, pl. 9, fig. 9.
1876. *Cuculligera perezii* I. Bolivar, *Syn. Orth. esp.* : 159, pl. 3.
1882. *Cuculligera flexuosa* Brunner von Wattenwyl, *Prod. eur. Orth.* : 179 (*nec* Serville !).
1904. *Cuculligera capucina* Navas, *Bol. Soc. aragon.* **3** : 193, fig.
1921. *Prionotropis flexuosa* var. *perezi* I. Bolivar, *R. Soc. esp. Hist. nat.*, **50 anniv.** : 458, figs. 4, 5.

Type locality. Brunete, 30 km. W. of Madrid.

2c. *Prionotropis flexuosa sulphurans* I. Bolivar 1921.

1921. *Prionotropis flexuosa* var. *sulphurans* I. Bolivar, *R. Soc. esp. Hist. nat.*, **50 anniv.** : 458.

Type locality. Teruel province : Muela de San Juan y de Albarracin.

3. *Prionotropis appulum* (Costa 1836).

1836. *Podisma appulum* Costa, *Fauna Regni Napol. Orth.* : 44, pl. 4, figs. 3A, b, c, d.
1923. *Prionotropis hystrix appula* Uvarov, *Ann. Soc. ent. Fr.* **91** : 246.
1937. *Prionotropis appula* Jannone, *Boll. zool. Napoli* **8** : 54, fig. 1 (1–4).
1937. *Prionotropis incisa* Jannone, *tom. cit.* : 53, fig. 1 (5–8) (**syn. n.**).

Notes. Jannone has distinguished amongst his specimens, collected together in the Taranto, Bari and Foggia provinces of Italy, two forms differing mainly in the apex of the male subgenital plate, which was entire in some and excised in others. The latter he regarded as specifically distinct from *appulum*, but Paoli (1937, *Redia* **23** : 193), who has collected in the same areas, regarded the forms with the apically excised plate as mere individual variation, and I am inclined to agree with him, since a tendency to develop an excision at the apex of the plate can be observed in individuals of other species as well. A male of *Prionotropis flexuosa* with such abnormality has been reported by Pantel

(1886, *An. Soc. esp. Hist. nat.* **15** : 273). Since other characters suggested by Jannone to separate *incisa* from *appulum* do not exceed the range of individual variation observed in members of this genus, and since the two reputed species were actually found in mixed populations, there is no alternative to synonymising *incisa* with *appulum*.

Brunner (1882, *Prodr. eur. Orth.* : 179) has recorded this species also from the Epirus. I have once (Uvarov 1923, *loc. cit.*) examined his specimen and did not find it different from the Italian ones, but more material must be studied to establish whether the Epirus is populated by a distinct subspecies.

A Sicilian record by Krauss (1878, *Sitzber. Akad. Wiss. Wien*, 1. Abt. **78** : 45) apparently based on that of Fieber (1853, *Lotos* **3** : 128, as *P. hystrix*) requires confirmation; if the species occurs there at all, it may be a distinct subspecies.

Type locality. Southern Italy : Apulia.

4. *Prionotropis hystrix* (Germar 1817).

As shown by me elsewhere (Uvarov 1923, *Ann. Soc. ent. Fr.* **91** : 245), this species is represented by several geographical races, inhabiting isolated areas of the Mediterranean coast from southern France to Dalmatia. Five such races were then recognised by me, but two of them (*appulum* and *rhodanica*) are sufficiently distinct to be raised to specific rank. Thus only three known subspecies remain, but it is highly probable that other isolated populations, when studied, will prove to belong to distinct subspecies.

4a. *Prionotropis hystrix hystrix* (Germar 1817), figs. 2, 23, 28, 40.

1817. *Gryllus hystrix* Germar, *Reise nach Dalmatien etc.* : 252, pl. IX, figs. 1, 2.
1878. *Cuculligera hystrix* Krauss, *Sitzber. Akad. Wiss. Wien.* 1. Abt., **78** : 41, pl. II, figs. 1–10.
1882. *Cuculligera hystrix* Brunner von Wattenwyl, *Prodr. eur. Orth.* : 178, fig. 41.
1923. *Prionotropis hystrix hystrix* Uvarov, *Ann. Soc. ent. Fr.* **91** : 246, fig. A.

Type locality. Dalmatian coast : island of Veglia.

4b. *Prionotropis hystrix sontiaca* Uvarov 1923.

1923. *Prionotropis hystrix sontiaca* Uvarov, *tom. cit.* : 246, fig. B.

Type locality. North-east Italy : Gorizia (Görz).

4c. *Prionotropis hystrix azami* Uvarov 1923.

1923. *Prionotropis hystrix azami* Uvarov, *tom. cit.* : 247, fig. C.

Type locality. Southern France, Var : Broves.

5. *Prionotropis rhodanica* Uvarov 1923.

1923. *Prionotropis hystrix rhodanica* Uvarov, *tom. cit.* : 247, fig. D.

Notes. I originally regarded this insect as a subspecies of *hystrix*, but it differs strikingly from other subspecies by the much more robust habitus, swollen pronotum (especially in metazona) and very broad sternum. It appears, therefore, more correct to regard it as a distinct species.

Type locality. Southern France, Bouches-du-Rhône : Crau.

EREMOPEZA Saussure 1884.

1884. *Eremoplana* Saussure, *Prodr. Oedip.* : 62, 232 (Preoccupied by *Eremoplana* Stål 1871).
1888. *Eremopeza* Saussure, *Addit. Prodr. Oedip.* : 133.

Genotype : *Eremobia cinerascens* Stål 1875 was the only species originally included in *Eremoplana* and, since *Eremopeza* was proposed as a new name for the same genus, it has the same genotype.

Diagnosis. Body distinctly compressed laterally, more or less rugulose and tuberculate; hairy. Head in frontal view decidedly higher than wide. Frontal ridge moderately compressed, shallowly sulcate above the ocellus, constricted below it, widening and obsolescent towards the clypeus; median ocellus placed at the level of the lower edge of the eyes. Vertex less than twice the width of an eye, even in the female; roundly projecting forward, moderately sloping, scarcely concave, without raised margins. Fastigium of vertex distinctly inflated, not marginate. Supraocellar foveola absent; preocellar foveola usually weakly defined but sometimes distinct, often joined to the concavity of the frontal ridge; there is usually a pair of contiguous upper submedian foveolae. Pronotum tectiform throughout, though sometimes only weakly so in metazona; median carina always at least as high in metazona as in prozona; metazona longer than prozona, strongly to distinctly (seldom weakly) convex in cross-section, with non-laminate margin, triangular in shape, but the apex rounded. Krauss's organ well developed, with weak linear rugosities. Tympanum sunken; subtympanal lobe large, covering about one-third of the tympanum. Wings always fully developed; second axillary vein moderately sinuate; disc of varying shades of blue, green and yellow; black fascia well developed (in some cases extending over the disc, the whole basal part becoming black) and always well defined, not touching hind margin (except in *E. afghana*); two apical lobes largely black (seldom only black-veined and infumate). Epiphallus (fig. 33) relatively narrow, with the apex truncate and weakly emarginate.

Notes. It would be difficult at present to reach definite conclusions as to which of the thirteen valid taxonomic units referable to this genus should be regarded as good species and which are only subspecies. The arrangement offered below must, therefore, be considered as a preliminary one, while the following key is purely artificial and based almost exclusively on colour characters; its use in determination must be followed by careful study of the original descriptions.

Artificial key to species and subspecies.

1(14). Hind tibia yellow to red, without blue colour (except the very base, which may be blue).
2 (3). Basal two-thirds of the wing black, followed by light-yellowish fascia, and two black apical lobes. Hind femur inside light red, sometimes with bluish " bloom "; hind tibia light sanguineous . 5. *E. festiva.*
3 (2). Wing disc yellow, greenish or blue.
4(11). Wing disc not blue.
5 (8). Hind tibia light-red, or sanguineous, without a bluish basal spot.
6 (7). Wing disc light sulphur-yellow . . . 1a. *E. cinerascens cinerascens.*
7 (6). Wing disc greenish, or bluish-green . . 1b. *E. cinerascens virescens.*
8 (5). Hind tibia orange, or rose, with a pale-blue basal spot.
9(10). Hind tibia orange. Wing fascia narrow, not touching the hind margin . . . . . 1c. *E. cinerascens aurantipes.*
10 (9). Hind tibia light-rose. Wing fascia broad, touching the hind margin 2. *E. afghana.*

11 (4). Wing disc blue.
12(13). Wing disc pure blue; fascia narrower. Hind tibia bright red
3a. *E. saussurei saussurei.*
13(12). Wing disc violaceous-blue; fascia broader. Hind tibia orange-red
3b. *E. saussurei violacea.*
14 (1). Hind tibia blue in at least two-thirds of its length.
15(18). Apex of hind tibia orange, or reddish. Pronotal carina weakly to moderately convex.
16(17) More robust and smaller; elytra not longer than 35 mm. in ♂, 40 mm. in ♀. Apical third of hind tibia light-orange. Wings sulphur-yellow, sometimes with greenish tinge; fascia rounded, wider than the light edge of the hind margin . 1d. *E. cinerascens bicoloripes.*
17(16). Slender and very large; elytra in ♂ over 45 mm., in ♀ over 50 mm. Only the apical fifth (or less) of the hind tibia orange or red. Wings light-blue to greenish-blue; fascia rectangular, not wider than the light edge of the hind margin . . . . . 6. *E. gigas.*
18(15). Hind tibia deep-blue, with the postbasal ring and the immediate apex ivory-white. Pronotal carina strongly convex.
19(24). Wing not yellow; apex distinctly darkened. Hind femur with a large blue spot at the base inside.
20(21). Wing mostly black, with blue tinge at the base
4a. *E. gibbera gibbera.*
21(20). Wings with blue, or greenish-blue disc.
22(23). Wing disc blue, occupies basal third of the wing; fascia broad (nine times the width of the light border); apical spots black
4b. *E. gibbera lata.*
23(22). Wing disc greenish-blue, occupies more than the basal third of the wing; fascia narrow (less than five times the width of the light border); first apical spot black, second only infumate
4c. *E. gibbera angusta.*
24(19). Wing light sulphur-yellow; fascia very narrow, often interrupted; apex with only veins and veinlets somewhat darkened. Hind femur without a blue basal spot inside 4d. *E. gibbera reducta.*

1a. *Eremopeza cinerascens cinerascens* (Stål 1875), figs. 4, 12, 18, 47.

1875. *Eremobia cinerascens* Stål, *Bih. Sven. Akad. Handl.* **3** (14) : 35.
1884. *Eremoplana cinerascens* Saussure, *Prodr. Oedip.* : 233.
1888. *Eremocharis* (subgenus *Eremopeza*) *cinerascens* Saussure, *Addit. Prodr. Oedip.* : 134.
1918. *Tmethis cinerascens* Uvarov, *Bull. Mus. Caucase* **12** : 50, fig. 5.
1926. *Tmethis cinerascens* Uvarov, *Konowia* **5** : 183, 186, fig. 3 (18).
1932. *Eremobia cinerascens* Sjöstedt, *Ark. Zool.* **24A** (1) : 25, pl. VII, fig. 1.
1933. *Tmethis cinerascens cinerascens* Uvarov, *Trav. Inst. zool. Acad. Sci. URSS* **1** : 212, 213.

Type locality. Stål described this insect merely from " Persia," but according to a letter from Professor Sjöstedt, the specimens in the Stockholm Museum (presumably the types) are from Shahrud in the Elburs mountains, and I propose to regard this as the type locality.

1b. *Eremopeza cinerascens virescens* (Uvarov 1933).

1933. *Tmethis cinerascens virescens* Uvarov, *Trav. Inst. zool. Acad. Sci. URSS* **1** : 212, 213.

Type locality. Western Iran, Irak–Adzhemi province: Kum.

1c. *Eremopeza cinerascens aurantipes* (Uvarov 1933).

1933. *Tmethis cinerascens aurantipes* Uvarov, *Trav. Inst. zool. Acad. Sci. URSS* **1** : 212, 213.

Type locality. Baluchistan: Quetta.

1d. *Eremopeza cinerascens bicoloripes* (Moritz 1928).

1928. *Tmethis cinerascens bicoloripes* Moritz, *Materialy po obsledovaniyu saranchevych nasekomych v Severnoi Persii za* 1927 *i* 1928 *g.g.* : 44.
1929. *Tmethis cinerascens bicoloripes* Uvarov & Moritz, *Ann. Mag. nat. Hist.* (10) **4** : 537.

Notes. The original description was in Russian, and in the English translation of it (1929) the coloration of the hind tibia was described incorrectly; the description in the key above (p. 42) is correct.

Type locality. Northern Iran, Khorasan province: Turbet-i-Kheidari.

2. *Eremopeza afghana* (Uvarov 1940).

1940. *Tmethis afghanus* Uvarov, *Ann. Mag. nat. Hist.* (11) **6** : 57, fig. A.

Notes. Possibly only another subspecies of *E. cinerascens*.

Type locality. Afghanistan: Arbarp, 10 miles west of Kabul, 3000 ft.

3a. *Eremopeza saussurei saussurei* (Uvarov 1918).

1916. *Tmethis gibber* Uvarov, *Bull. Mus. Caucase* **10** : 183 (*nec* Stål !).
1918. *Tmethis saussurei* Uvarov, *tom. cit.* **12** : 49, fig. 3.

Notes. When describing this insect (1918, *tom. cit.*) I quoted *Eremobia gibbera* var. 1 of Saussure (1884) as a synonym, but it must be referred to *Eremopeza gibbera lata* (see below).

Type locality. North-western Iran: Danalu (selected here).

3b. *Eremopeza saussurei violacea* (Uvarov 1922).

1922. *Tmethis saussurei* ab. *violacea* Uvarov, *J. Bombay nat. Hist. Soc.* **28** : 362.
1923. *Tmethis saussurei violacea* Uvarov, *tom. cit.* **29** : 646.

Type locality. Southern Iran: Abadeh.

4a. *Eremopeza gibbera gibbera* (Stål 1876), figs. 19, 27, 33.

1876. *Eremobia gibbera* Stål, *Bih. Sven. Vet.-Akad. Handl.* **4** (5) : 27.
1884. *Eremobia gibbera* Saussure, *Prodr. Oedip.* : 227, 231 (*partim* !).
1932. *Eremobia gibbera* Sjöstedt, *Ark. Zool.* **24A** (1) : 24, pl. 7, fig. 2.
1934. *Tmethis gibber gibber* Uvarov, *Eos* **10** : 104.

Notes. As already stated by me (1934, *tom. cit.* : 103), Saussure (1884, *loc. cit.*) has correctly differentiated between *E. gibbera* of Syria and *E. festiva* of Armenia, but his description of *E. gibbera* was based on a mixture of both species, therefore he has described the hind tibiae varying in colour from red to blue. Actually, the deep-blue colour of hind tibia constitutes a perfectly constant character of *E. gibbera* and all its known subspecies.

Type locality. Stål (1876, *loc. cit.*) has described this insect from "Syria," but Saussure (1884, *loc. cit.*) has stated definitely that Stål's type was from Aleppo.

4b. *Eremopeza gibbera lata* (Uvarov 1934).

1884. *Eremobia gibbera* var. 1, Saussure, *Prodr. Oedip.* : 231.
1934. *Tmethis gibber latus* Uvarov, *Eos* **10** : 105.

Type locality. Iraq, Arbil district: Zirga Zarow hills.

4c. *Eremopeza gibbera angusta* (Uvarov 1934).

1924. *Tmethis carinatus* Uvarov, *Bull. Min. Agric. Egypt* **41** : 33, 34, pl. III, figs. 39, 40 (*nec* Fabricius !).
1934. *Tmethis gibber angustus* Uvarov, *Eos* **10** : 105.

Type locality. Iraq : Khanaqin.

4d. *Eremopeza gibbera reducta* (Uvarov 1934).

1934. *Tmethis gibber reductus* Uvarov, *Eos* **10** : 106.

Notes. This subspecies deviates considerably from the other three, not only in the colour characters (see key, p. 42), but also in the more slender habitus, and may be distinct specifically.

Type locality. S. Iran : Bushire to Burusdjun.

5. *Eremopeza festiva* (Saussure 1884).

1884. *Eremobia festiva* Saussure, *Prodr. Oedip.* : 227, 231.
1886. *Eremobia grandis* Portschinsky, *Horae Soc. ent. ross.* **20** : 111, pl. XII, figs. 5, 7, 9, 11.
1888. *Eremobia grandis* Saussure, *Addit. Prodr. Oedip.* : 127, 128.
1897. *Eremobia* (*Cuculligera*) *grandis* Portschinsky, *Horae Soc. ent. ross.* **30** : 932, pl. X, fig. 15.
1901. *Eremobia grandis* Portschinsky, *Ent. Rec.* **13** : 211.
1918. *Tmethis gibber* Uvarov, *Bull. Mus. Caucase* **12** : 48, figs. 1 & 2; 158 (*nec* Stål !).

Notes. There are only two black-winged members of this genus, the Syrian *E. gibbera gibbera* and *E. festiva*, and they differ so strikingly in the coloration of hind legs that I am inclined to separate them specifically until connecting forms are proved to exist. The structural differences given in Saussure's key (1884, *tom. cit.* : 227) do not seem to be reliable, while in the text (*loc. cit.* : 231) he has described *festiva* from mixed material, thus causing a confusion, which led me (Uvarov 1918, *loc. cit.*) to regard *festiva* as a pure synonym of *gibbera*, a view I am unable to support now when I have before me good series of both insects. Thus *festiva* should be restored as a good species.

The original description of *Eremobia grandis* by Portschinsky was in Russian, and, although detailed in some respects, missed such an important character as the colour of the hind-wings. On the other hand, the author has called elytra " wings," and this led Saussure to believe that the species has bluish wings, instead of black (bluish-grey coloration of all external parts, including elytra, is common in *E. festiva* occurring on soil of similar colour). This accounts for Saussure's failure to recognise that Portschinsky's species was identical with *festiva*, and I was the first (Uvarov 1918, *loc. cit.*) to establish the synonymy of *E. grandis*.

Type locality. Saussure merely quoted " Persia," but it is probable that the type (No. 14621 in Brunner's collection in the Vienna Museum) bears a more definite locality label. A specimen from Brunner's collection, now in the British Museum, is from Ordubad in the Araxes valley. As far as I know, *E. festiva* is restricted to that valley and the neighbouring mountains of Armenia. The type locality for *E. grandis* is Erivan.

6. *Eremopeza gigas* (Kirby 1914).

1914. *Sphingonotus gigas* Kirby, *Fauna Brit. India, Acrid.* : 154, 158.
1922. *Tmethis hotsoni* Uvarov, *J. Bombay nat. Hist. Soc.* **28** : 363 (syn. n.).
1923. *Tmethis hotsoni* Uvarov, *op. cit.* **29** : 647.
1933. *Tmethis hotsoni* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 212, pl. I, fig. 2.

Notes. I have now before me a good series of specimens of my *Tmethis*

hotsoni from various localities in Baluchistan, and am able to confirm my previous suggestion (1923, *loc. cit.*) that it should be considered conspecific with *Sphingonotus gigas*. The type of the latter could not be traced, but the description fits *T. hotsoni* in every respect, including the size, which is remarkable even for an *Eremopeza*, and quite beyond the range of any *Sphingonotus*.

Type locality. Baluchistan : Mand.

Iranotmethis gen. n.

Genotype : *Eremobia cyanipennis* Saussure 1884.

Diagnosis. Allied to *Eremopeza*, but more robust and with somewhat abbreviated organs of flight, differing from it also in broader fastigium of vertex; minute ocelli; abdominal tergites bearing compressed folds at hind margins; the upper carina of hind femur straight in profile, not concave before the knee; the wing with a broad diffuse fascia and dark-veined apical portion, without definite apical spots.

Notes. Most members of this genus are known from single specimens, some of them poorly preserved and of doubtful origin. It is probable that some of them will prove to be synonymous, while others may be merely geographical races of one species.

1. *Iranotmethis cyanipennis* (Saussure 1884).

1884. *Eremobia cyanipennis* Saussure, *Prodr. Oedip.* : 227, 232.

Notes. I have before me a pair of types, male and female, from Brunner's collection. They are relatively small (see table p. 46), pronotum very densely granulate and with some scattered low tubercles. The male (selected here as the type) has the inner face of hind femur steel-blue, fading apically; inner knee-lobe with a blue basal spot; hind tibia blue with a violaceous shade, particularly towards the apex. In the female both the inside of hind femur and hind tibia are very light carmine.

Type locality. The type specimens are labelled " Chiva. Plason ded.", but I have already suggested (*Eos* **2** : 359) that this is a case of mislabelling and the species originated from Iran. This suggestion is supported by the existence in northern Iran of very closely allied, perhaps even identical, species listed below.

2. *Iranotmethis persa* (Saussure 1888).

1888. *Eremobia persa* Saussure, *Addit. Prodr. Oedip.* : 127, 128.
1918. *Tmethis persa* Uvarov, *Bull. Mus. Caucase* **12** : 50, fig. 4.

Notes. Described from a single, apparently discoloured, female and known to me also from a discoloured pair. Seems to differ from *I. cyanipennis* by larger size, more rugose and more acutely angulate pronotum, resembling in these respects *I. zagrosi* (see below).

Type locality. Persia. My specimens (*loc. cit.*) were from the vicinity of the lake Urmia in N.W. Persia.

3. *Iranotmethis zagrosi* (Uvarov 1933).

1933. *Tmethis persa zagrosi* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 213.

Notes. Resembles Saussure's description of *I. persa* as regards size and the sculpturing of pronotum, and is characterised by pale carmine coloration of hind

femur and tibia in both sexes (colour of these parts in *I. persa* not known). Possibly a mere synonym of *I. persa*.

Type locality. Iran, Kermanshah province: Harunabad.

4. *Iranotmethis* sp.

1933. *Tmethis persa persa* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 213 (*nec* Saussure !).

Notes. The insect redescribed by me as *persa* from Khane, in the Lahidzhan valley of the Persian Kurdistan was probably distinct from Saussure's species, because the female had deep blue hind femur and hind tibia and the pronotum resembled rather that of *I. cyanipennis*. It is possible that my insect was a subspecies of the latter, but I have no specimen before me now.

Measurements of *Iranotmethis* spp.

	Body		Pronotum		Elytra		Hind femur	
	♂	♀	♂	♀	♂	♀	♂	♀
I. cyanipennis . .	37	45	12	14	32	18	20	23
I. persa . . .	—	51	—	18	—	23	—	25
I. zagrosi . .	39	54	13·5	15	31	18	20	26

Eremotmethis gen. n.

Genotype: *Gryllus carinatus* Fabricius 1775.

Diagnosis. Intermediate in the general appearance between *Asiotmethis* and *Eremopeza*, with the integument generally smoother than in either of them, though often covered with more or less scattered tubercles. Head as in *Eremopeza*, but the frontal ridge between antennae more compressed and sulcate; fastigium without any foveolae (or with weakly defined foveolae in the most roughly sculptured individuals). Prozona of the pronotum with high tectiform tripartite carina, the hindmost section being very narrow, acute and directed backwards; metazona broader than long, broadly parabolic behind, surface convex in both directions, shoulders prominent, hind edge not laminate; metazonal carina well developed, viewed in profile not lower than the prozonal carina, but strongly lowered towards the typical sulcus. Subtympanal lobe as in *Eremopeza*. Krauss's organ well developed, bearing small tubercles and irregular, parallel ridges. Hind femur broader than in *Eremopeza*, similar to that in *Asiotmethis*, but without the notch of upper margin. Tarsal arolia about one-third the length of a claw, broad. Mesosternal transverse furrow strongly curved backwards between the lobes; mesosternal and metasternal interspaces very broad. Elytra less coriaceous than in other genera, with more regular transversely elongate cells in the discoidal and the furcal areas. Wings with a weak, broadly curved, narrow fascia (often obsolescent), placed at two-thirds of the length of costal margin from the base; apex not spotted. Epiphallus with the apical portion projecting and weakly bilobate.

1. *Eremotmethis carinatus* (Fabricius 1775).

1775. *Gryllus carinatus* Fabricius, *Syst. Ent.* : 288.
1839. *Eremobia carinata* Serville, *Ins. Orth.* : 706.
1839. *Eremobia continuata* Serville, *tom. cit.* : 707.
1924. *Tmethis aegyptius* Uvarov, *Bull. Min. Agric. Egypt* **41** : 34, pl. III, figs. 41, 42.
1929. *Tmethis carinatus* Innes Bey, *Mem. Soc. r. entom. Egypte* **3** (2) : 97, pl. II, figs. 7.
1929. *Tmethis moritzi* Uvarov, *Ann. Mag. nat. Hist.* (10) **4** : 537, fig. (**syn. n.**).
1934. *Tmethis carinatus carinatus, c. continuatus, c. moritzi* Uvarov, *Eos* **10** : 100–103, figs. 29–31.

Notes. The confusion regarding this species has been cleared up by me (1934, *loc. cit.*), but at that time I distinguished three subspecies, differing in minor structural and colour details. At present I have before me good series of specimens from Egypt, southern Palestine, Arabia (Jidda and Kuwait), Baluchistan and Afghanistan (Harirud) and am unable to support the earlier subspecific division.

Type locality Arabia: Jidda (see Uvarov 1934, *loc. cit.*).

Tuarega gen. n.

Genotype: *Oedipoda insignis* Lucas 1851.

Diagnosis. Body depressed, rugulose and tuberculate; hairy. Head in frontal view higher than wide. Frontal ridge scarcely compressed, flat, wide above ocellus, gradually narrowed and obsolescent below it; median ocellus placed below the level of the lower edge of eyes. Vertex less than twice the width of an eye, even in the female; scarcely prominent forward, moderately sloping, weakly concave, margins wavy, incrassate, but scarcely raised. Fastigium of vertex somewhat convexly sloping, not marginate. Supraocellar foveola very faintly indicated, or obsolete; preocellar foveola more distinct, but irregular; a pair of weakly defined contiguous upper submedian foveolae. Pronotum tranversely rounded in the strongly constricted prozona, and flat in metazona; transverse sulci weak; median carina completely absent, or very faintly indicated by a smooth line in the prozona; metazona with strongly prominent shoulders, broadly parabolic, nearly three times as long as prozona. Krauss's organ well developed, finely rugulose and tuberculate. Tympanum sunken; subtympanal lobe large, covering about one-third of the tympanum. Elytra very long, with very regular cross-veins in the apical portion Wings large; second axillary vein sinuate; disc light-yellow; dark fascia narrow, not touching hind margin, with an incomplete radial branch; apical lobes dark-veined. Epiphallus elongate, with a truncate apical projection.

1. *Tuarega insignis* (Lucas 1851), figs. 15, 42, 52.

1851. *Oedipoda insignis* Lucas, *Ann. Soc. ent. Fr.* (2) **9** : 370.
1854. *Eremobia jaminii* Lucas, *tom. cit.* (3) **2** : 711, pl. 20, figs. 1, 1a–d.
1884. *Eremobia insignis* Bonnet et Finot, *Rev. Sci. nat. Montpellier* (3) **4** : 221.
1884. *Batrachotettix elephas* Saussure, *Prodr. Oedip.* : 236, 237.
1888. *Eremocharis* (*Eremocharis*) *insignis* Saussure, *Addit. Prodr. Oedip.* : 134, 135.
1895. *Eremocharis insignis* Finot, *Ann. Soc. ent. Fr.* **44** : 487.
1941. *Eremocharis insignis* Roberts, *Proc. Acad. nat. Sci. Philadelphia* **93** : figs. 24, 31.

Type locality. Algeria: Kefoum-Tebouc, near Tunisian border.

EREMOCHARIS Saussure 1884.

1884. *Eremocharis* Saussure, *Prodr. Oedip.* : 63, 233.
1888. *Eremopeza* subgenus *Eremocharis* Saussure, *Addit. Prodr. Oedip.* : 134.

Genotype: *Eremobia subsulcata* Stål 1875, the only species originally included.

Diagnosis. Body moderately compressed laterally, hairy. Head in frontal view higher than wide. Frontal ridge compressed, narrow, weakly sulcate, above ocellus somewhat wider than below it, strongly narrowed and obsolescent towards the clypeus; median ocellus a little below the level of the lower edge of eye. Vertex in female twice, in male less than twice, the width of an eye; very distinctly and angularly projecting forward, moderately sloping, more or less concave, with the margins at least weakly raised. Fastigium of vertex not inflated; its upper surface forming a distinct angle (usually carinate)

with the lateral slopes. Supraocellar and preocellar foveolae present, but weak and irregular; preocellar foveolae on vertical plane, not visible from above. Pronotum weakly tectiform, but metazona concave on both sides of the median carina, which is gradually lowered behind and disappears before reaching the apex; the carina is very weakly incised by the sulci and always finely sulcate at least in prozona; metazona distinctly longer than prozona (except in one brachypterous species), with acute posterior angle and straight incrassate margins. Krauss's organ well developed, with weak linear rugosities or tubercles. Tympanum sunken; subtympanal lobe covering about one-third of the tympanum. Wings fully developed to partially abbreviated; second axillary vein moderately sinuate; disc of varying light shades of yellow, blue and green; dark fascia, when fully developed, touches the hind margin, but is often reduced and even split up into spots; apical lobes never blackened. Epiphallus transverse, with a very weak and broad apical projection (similar to fig. 35).

Notes. This genus, as defined now, is admittedly less homogeneous than others, and most of the species referred to it are remarkable for their plasticity, which makes it difficult at present to offer their classification, except in a very tentative way. A list of species, once prepared by me (Uvarov, 1933, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 219), has now been revised, and *E. insignis* removed to a new genus, *Tuarega*, while *E. syriaca* I. Bolivar has been proved to belong to the genus *Utubius* (Uvarov, 1938, *Field Mus. nat. Hist., Zool.* **20** : 337). The majority of the known species are now regarded by me tentatively as subspecies of *E. granulosa*, and only four species, including one new, are recognised.

1. *Eremocharis subsulcata* (Stål 1875), figs. 5, 16, 17.

1875. *Eremobia subsulcata* Stål, *Bih. Sven. Akad. Handl.* **3** (14) : 35.
1884. *Eremocharis subsulcata* Saussure, *Prodr. Oedip.* : 234.
1932. *Eremobia subsulcata* Sjöstedt, *Ark. Zool.* **24A** (1) : 25, pl. 6, figs. 2 (male type), 4 (female cotype mistakenly called on pp. 25 and 87 *Eremobia cinerascens*).
1933. *Eremocharis subsulcata* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 220; pl. I, fig. 3.

Notes. Differs strikingly from other known species by the relatively more slender habitus; sulphur-yellow colour of hind-wings with sharply defined fascia which has no trace of radial branch; and particularly by the inner spines of hind tibia being only black-tipped, not entirely black.

Type locality. Stål's original indication was merely " Persia," but I have been informed by Professor Sjöstedt that the type is labelled Shahrud (Elburs mountains).

2. *Eremocharis granulosa* (Walker 1871).

Notes. The material at hand, although reaching almost a hundred specimens from different localities in north-western Baluchistan and Eastern Persia, is still considered insufficient for forming definite conclusions as to the number and limits of geographical forms, or of independent species. The impression is that we are faced with a large number of minor local forms, of a different degree of stability, but it would probably lead to great confusion if an attempt were made to evaluate them all in taxonomic terms by merely studying the collection of specimens. The case is so complicated that one can only hope to arrive at its proper understanding by making extensive investigations on the spot, where morphological differences between various forms might be studied parallel with their distribution, both topographical and ecological. The following list of recognisable subspecies should, therefore, be considered mainly as a guide to the main lines of intraspecific variation,

and will probably require drastic revision in the future. Several undescribed local forms represented in the material before me by single, or few, specimens are not included in the list.

2a. **Eremocharis granulosa roseipes** subsp. n.

Diagnosis. Slender, of medium size; prozonal carina acutely tectiform, its sides not swollen; elytra in both sexes extending well beyond the apex of abdomen; wings pale greenish-yellow (or pale yellow); fascia well defined (without radial branch); its inner outline rounded-rectangular; hind femur and hind tibia on the inside light-rose.

Notes. In the wing pattern (and often in the colour of its disc), as well as in the slender habitus, this subspecies is similar to *E. subsulcata*, but is much smaller and quite distinct from it in the coloration of the hind legs, and especially in the entirely black inner tibial spines. Some specimens from Khan Mehterzai may be regarded as transitional from this subspecies to subsp. *granulosa*, as their wing fascia tends to become weaker and interrupted, while the basal portion of hind tibia develops a bluish tinge and the tibia becomes bi-coloured.

Type locality and distribution. BALUCHISTAN: Khan Mehterzai, 7000 ft., v.1931, 8 ♂♂ (including the type); Ziarat, 8600 ft., iv.1931, 1 ♂; Gwal, 6000 ft. (E. of Quetta, near Bostan), iv.1931, 2 ♂♂; Juniper Kotal, 7500 ft. (near Quetta, on the road to Kachh), 16.v.1931, 2 ♂♂, 1 ♀; Wam Kotal, 7500 ft. (on the Quetta–Ziarat road), 23.v.1931, 3 ♂♂ (*D. Harrison*); Mehterzai Pass, 26.vii.1930, 1 ♂ (*W. H. Evans*).

Specimens transitional to subsp. *granulosa* (not considered paratypes of subsp. *roseipes*): Khan Mehterzai, v.1931, 2 ♂♂, 2 ♀♀; Juniper Kotal, 16.v.1931, 5 ♂♂.

2b. *Eremocharis granulosa granulosa* (Walker 1870).

1871. *Oedipoda granulosa* Walker, *Cat. Derm. Salt. Brit. Mus.* **5** (Suppl.) : 76.
1888. *Eremocharis* (*Eremopeza*) *granulosa* Saussure, *Addit. Prodr. Oedip.* : 134.
1902. *Eremocharis granulata* (*sic* !) Jacobson *in* : Jacobson and Bianki, *Pryamokr. Lozhnoset. Ross. Imp.* : 197 (but *E. granulosa* on p. 287).
1910. *Eremopeza granulosa* Kirby, *Syn. Cat. Orth.* **3** : 290.
1933. *Eremocharis granulosa* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 220.

Notes. Similar to the preceding subspecies, but wing disc more yellow; fascia not sharply defined and tending to be interrupted; hind tibia pale blue becoming rose in the apical quarter.

Type locality and distribution. The type, a male collected by Dr. Leith, is labelled "Quetta, Baluchistan". Other specimens are from Kachh, 26.vii.1931, 4 ♂♂, 3 ♀♀ (*M. Sharif*).

2c. *Eremocharis granulosa clavicornis* Ramme 1939.

1939. *Eremocharis clavicornis* Ramme, *Mitt. zool. Mus. Berlin* **24** : 134, fig. 54, pl. II, fig. 1.

Notes. Appears very similar to subsp. *granulosa*, the only difference discernible without studying the type being that the wing fascia has a distinct radial branch. Hind tibia is said to be bright red in the apical third; this type of coloration is observed in one male of subsp. *granulosa* from Kachh, while in others the coloration of the tibial apex is paler. The flattening of the apical antennal segment, stressed by Ramme, can be observed in various species of the genus, either as an individual feature, or perhaps due to drying.

Type locality. Afghanistan: 50 km. south of Kabul.

2d. *Eremocharis granulosa brachycera* (Kirby 1914).

1914. *Eremopeza brachycera* Kirby, *Fauna Brit. India, Acrid.* : 158, 159, fig. 110.
1923. *Eremocharis brachycera* Uvarov, *J. Bombay nat. Hist. Soc.* **29** : 647 (*partim* !).
1933. *Eremocharis brachycera* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 220 (*partim* !).

Notes. Differs from subsp. *granulosa* in the elytra of both sexes not extending beyond hind knees; prozonal carina thick, with the sides inflated; wing disc pale greenish, slightly infumate, and the fascia tending to form a radial branch; hind tibia greyish-blue, with the apical portion sandy coloured.

Type locality and distribution. The type is a discoloured female from Quetta (redescribed in Uvarov, 1923, *loc. cit.*). Other specimens are from Quetta, 25.iv.1933, 1 ♀, 15.v.1933, 1 ♀, and 26.v.1933, 1 ♀; Chiltan forest, 7000 ft. (10–15 miles S.W. of Quetta), 14.v.1931, 5 ♂♂, 3 ♀♀ (*D. Harrison*).

Two specimens (male and female) from Quetta, 15.v.1933, agree with subsp. *brachycera* in the coloration of hind tibia, but are slender and long-winged, resembling in this respect subsp. *granulosa*, being larger in size. They remain undetermined subspecifically.

2e. **Eremocharis granulosa rufipes** subsp. n.

Diagnosis. Small, but robustly built. Elytra in male just reaching the apex of abdomen, in female not extending beyond the hind knee. Prozonal carina thick, its sides swollen. Wing colourless, but faintly infumate throughout, so that the fascia, which is poorly defined, is scarcely delimited from the disc, but has a distinct radial branch. Hind femur wide and short; inside of the femur and of the tibia red.

Notes. This subspecies is a diminutive replica of subsp. *brachycera*, which it resembles in its habitus and the length of elytra, but differs from it in the coloration of wings and particularly that of hind legs. In the last-named character, there is a resemblance to subsp. *roseipes*, but the colour is pure red, not rose, and the two subspecies differ well in habitus, length of elytra and coloration of wings.

Type locality and distribution. Baluchistan: Ziarat, 7500 ft., 3.v.1930, 3 ♂♂ (including the type), 2 ♀♀ (*W. H. Evans*); 6.viii.1929, 1 ♀ (*J. W. Evans*); 1–15 viii.1930, 1 ♂, 1 ♀ (*W. H. Evans*); iv.1931, 1 ♀ (*D. Harrison*); 7.viii.1931, 2 ♂♂, 5 ♀♀ (*M. Sharif*); Pechi, 7500 ft., 1.iv.1931, 2 ♂♂ (*D. Harrison*); Bolan, iv.1931, 1 ♀ (*D. Harrison*).

2f. *Eremocharis granulosa bampura* Uvarov 1933.

1933. *Eremocharis bampura* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 216, 220, pl. I, fig. 4.

Notes. Very similar to subsp. *brachycera*, but larger and with a reduced wing fascia.

Type locality. S.E. Iran, Bampur province: Kuusha-Larumba.

2g. *Eremocharis granulosa khorasana* Uvarov 1933.

1933. *Eremocharis khorasana* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 214, 220, pl. I, fig. 1.

Notes. A long-winged subspecies, similar in habitus to subsp. *granulosa*, but differing in larger size, the coloration of hind tibia, and strongly reduced wing fascia.

Type locality. E. Iran, south-east of the Khorasan province: near lake Dakipatargun.

3. *Eremocharis afghana* Ramme 1928.

1928. *Eremocharis afghana* Ramme, *Deutsch. ent. Z.* **1928** : 299, pl. VII, figs. 3a, 3b.

Notes. This is probably a distinct species, characterised mainly by the sexual dimorphism in wing development, the male being quite long-winged, while the female elytra are considerably shorter than the hind femora.

The insect recorded by me under this name from Baluchistan (Uvarov, 1933, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 218, pl. I, fig. 5) is a form of *E. granulosa*, transitional in its characters between subsp. *roseipes* and subsp. *granulosa*.

Type locality. Afghanistan : Paghman Mts. near Kabul.

4. **Eremocharis wazira** sp. n.

Differs strikingly from other known species by the elytra and wings in both sexes being shorter than the length of the pronotum, and by the relatively short metazona of the pronotum. Otherwise fairly close to *E. granulosa rufipes*, with which it agrees in the colour of hind tibia, but the inside of hind femur is not red.

♂ (*type*). Moderately rugulose, densely covered by small sand-like granules.

Antennae shorter than head and pronotum together, flattened, somewhat expanded apically. Frontal ridge strongly laterally compressed, scarcely sulcate, weakly excised below the ocellus. Vertex weakly sloping, distinctly concave, with almost continuous margins.

Pronotum laterally compressed. Median carina distinctly tectiform throughout, gradually lowered in metazona, becoming obsolete in its apical third; in prozona it is finely sulcate and slightly notched by weak sulci. Metazona with shallow depressions parallel to lateral margins; its length scarcely greater than that of prozona; apex acute.

Elytra extending a little beyond the middle of the abdomen; pre-radial area wide; apex narrowly parabolic. Wings less than half the length of elytra.

Middle tibia without stridulatory tubercles. Hind femur short and broad; upper carina very weakly and irregularly serrate; lower carina weakly undulate.

Apex of abdomen recurved.

Coloration greyish above, rufous on the sides. Wing somewhat infumate. Hind femur on the inside dirty greyish-white; inner knee-lobe bluish-black, with a transverse fascia and the apex yellowish. Hind tibia on the inside red, except the base, which is dark blue; inner spines dark brown on the inside.

♀ (*paratype*). Much more rugose and tuberculate than the male type (though other paratypic females agree with the type in this respect). Elytra extending to the fourth abdominal tergite. Wings less than half the length of elytra. Both carinae of hind femur more undulate than in the male type.

Length of body ♂ 19, ♀ 29; pronotum ♂ 7, ♀ 10; elytra ♂ 6·5, ♀ 9·5; hind femur ♂ 11, ♀ 13 mm.

Type locality. India, North-western Frontier province, Waziristan : Razmak, 27.v., 3 ♂♂ (including the type), 6 ♀♀, 5 larvae.

Atrichotmethis gen. n.

Diagnosis. Similar to *Asiotmethis*, but different from it in the somewhat inflated fastigium of vertex (resembling *Eremopeza* in this respect); more slender habitus; narrow hind femur with the upper carina straight in profile (fig. 49); absence of acutely produced

folds at the hind edges of abdominal tergites; long and slender male cercus; almost complete absence of pilosity on body and legs; and broad wing fascia which is equally well defined on both sides.

Genotype : *Eremobia semenowi* Zubowsky 1899.

1. *Atrichotmethis semenowi* (Zubowsky 1899), fig. 49.

1899. *Eremobia semenowi* Zubowsky, *Horae Soc. ent. ross.* **32** : 581.
1926. *Tmethis semenowi* Uvarov, *Konowia* **5** : 181, 185, fig. 2 (12).

Type locality. Transcaspia : Annau (selected here).

2. *Atrichotmethis zaitzevi* (Uvarov 1918).

1918. *Tmethis zaitzevi* Uvarov, *Bull. Mus. Caucase* **12** : 52, fig. 6.

Notes. A doubtful species which has been found only once, although the locality is well known. When describing it, I was unable to compare it with the preceding species, and although the type is inaccessible at present, the description reveals no differences between them. It is not improbable that the type was a Transcaspian insect mislabelled " Tiflis ", in which case the species would become a synonym of *A. semenowi*.

Type locality. Caucasus, Tiflis : Botanical Garden.

Asiotmethis gen. n.

Genotype : *Gryllus muricatus* Pallas 1771.

Diagnosis. Body more or less depressed; rugulose and tuberculate; hairy. Head in frontal view wider than high. Frontal ridge moderately compressed, deeply sulcate, broad, with a sharp transverse ridge above ocellus, suddenly narrowed below it, widening again at clypeus : median ocellus placed distinctly below the level of the lower edge of eyes. Vertex more than twice the width of an eye even in the male, weakly projecting forward, strongly sloping; weakly concave, with moderately raised outer margins forming a distinct scutellum which is almost closed behind. Fastigium of vertex represented by a smaller scutellum. Supraocellar foveola placed on the almost horizontal side of the vertex, transverse to elongate in shape, with all margins usually well raised; preocellar fovcola well defined, elongate and excavate. Pronotum with the median carina in prozona strongly to moderately raised, tectiform and tripartite; in metazona linear but distinct; metazona is not, or weakly, convex in cross-section, more or less depressed just behind the typical sulcus; the length of metazona is usually greater than that of prozona, but becomes less in brachypterous species; margins of metazona always thin, laminate; posterior angle rounded. Prosternum with weakly reflexed front margin. Krauss's organ well developed, with dense acute tubercles. Tympanum sunken; subtympanal lobe small. Elytra well developed or reduced, but broadly oval in shape even in the most brachypterous species. Wings always present; second axillary vein strongly sinuate, disc hyaline, or faintly yellowish, bluish or greenish; dark fascia more or less developed but never sharply defined, usually emitting a radial branch; apical portion usually dark-veined, but without large apical spots. Epiphallus (fig. 35) strongly transverse, apex not projecting.

Notes. The systematics of species and lower units within this genus are in a chaotic state, but a thorough revision would require much more abundant material than is available to me at present. My treatment of the various forms as species, or as subspecies, is purely tentative and may require drastic

modifications. The following list, however, may be useful to a future reviser because it includes all described forms, and special care has been taken to assign the type locality to each one of them. A partial revision has been published by me before (1926 *Konowia* **5** : 180–181), but references to figures in the key were all incorrect; the correct references are given below.

1. *A. muricatus* (Pallas 1771), figs. 1, 9, 20, 26, 29, 51.

This species is known to be subject to considerable variation, particularly the colour of the inner face of the hind femur and tibia. The variation appears to be correlated with geographical distribution (though the possibility of sexual dimorphism must be also taken into account), but more work is necessary to establish the taxonomic status and the geographical limits of different forms. Therefore, the following list of subspecies should be used merely for the guidance of a future reviser.

1a. *Asiotmethis muricatus muricatus* (Pallas 1771).

1771. *Gryllus muricatus* Pallas, *Reise nach versch. Prov. Russ. Reichs* **1** : 466.
1813. *Gryllus Locusta pallasii* Stoll, *Nat. Afbeld. Beschrij. Spoken, etc.* : 25, pl. XIb, fig. 40, Register, p. 12.
1926. *Tmethis muricatus* Uvarov, *Konowia* **5** : 180, figs. 1 (1, 2), 4 (20).

Notes. According to Tarbinsky (1930, *Konowia* **9** : 188), this subspecies is characterised by the hind femur being bluish-black only in the basal half, the apical half and the lower edge being carmine-reddish; hind tibia is reddish-violet. It is not certain, however, whether this diagnosis would apply to specimens from the type locality which Tarbinsky has determined incorrectly (see below).

A colour form characterised by narrow lemon-yellow front and hind edges of pronotum has been described as var. *flavolimbus* Vorontsovsky 1928 (*Izvest. Orenburg. Sta. Zastch. Rast.* **1** : 21) from the neighbourhood of Orenburg. It is clearly an individual aberration, reappearing in several other species and subspecies, though usually only the hind pronotal margin has the yellowish edge. It should be called f. *flavolimba*, without author's name (see p. 35).

Type locality. The boundary between the Orenburg and the Aktubinsk provinces of the northern Kirghiz steppes (now Kazakhstan) has been quoted by Tarbinsky (*loc. cit.*) as the type locality, but Pallas (*tom. cit.*) mentioned the species for the first time on p. 229 where he called it a new species taken on the heights at the edge of the river valley near the fortress Tatischeva, west of Orenburg. The species is further mentioned by Pallas from Karaulnaya Gora near Iletsk (p. 239), Aspidnaya Gora near Orsk (p. 262), and Krivozerskaza on R. Irtysh below Semipalatinsk (**2** : 488). After describing the species (p. 466) Pallas merely said that the species is particularly frequent east of the Yaik (now Ural) river, and I formally propose to regard Tatischeva (which is on the west side of the river) as the type locality.

1b. *Asiotmethis muricatus australis* (Tarbinsky 1930).

1930. *Tmethis muricatus australis* Tarbinsky, *Konowia* **9** : 188.

Notes. Hind femur bluish-black, with reddish lower edge and a small yellowish, or reddish, preapical spot; hind tibia violet. Appears to be very close to the next subspecies.

Type locality. Kazalinsk district, Syr-Darya province of Northern Turkestan.

1c. *Asiotmethis muricatus lugubris* (Herrich-Schaeffer 1838).

1838. *Gryllus lugubris* Herrich-Schaeffer in : Panzer, *Fauna Ins. Germ.*, fasc. CLVI, pl. 20.

Notes. Hind femur black, with two red preapical spots; hind tibia blue.
Type locality. " Siberien," which may mean anywhere east of the Ural.

1d. *Asiotmethis muricatus tauricus* (Tarbinsky 1930).

1930. *Tmethis muricatus tauricus* Tarbinsky, *Konowia* **9** : 188.

Notes. Hind femur and hind tibia cinnabar-red.
Type locality. Crimea : Saki.

1e. *Asiotmethis muricatus fasciatus* (Fischer de Waldheim 1846).

1846. *Thrinchus muricatus* var. *fasciatus* Fischer de Waldheim, *Nouv. Mem. Soc. Imp. Nat. Moscou* **8** : 261.

Notes. According to the original description, agrees with *muricatus* Pallas in the violet coloration of the inner face of hind femur, but differs from it in pronounced black fasciae and spots on the elytra and on the outer face of the hind femur; this difference might be due to individual, or to ecological, variation. The difference in the terminal antennal segment, which is described as oval and flattened in *fasciatus*, is probably due to preservation. More important appears the greater rugosity of the pronotum, the prozonal carina of which is said to be strongly trilobate; this would indicate a similarity to *A. jubatus* and it is not impossible that the latter is synonymous with *fasciatus*, though no decision can be reached without comparing topotypes of both species.
Type locality. Transbaikalia : Verkhneudinsk. It should be noted that this may be an error, since no *Asiotmethis* has yet been recorded so far east.

2. *Asiotmethis jubatus* (Uvarov 1926).

1926. *Tmethis jubatus* Uvarov, *Konowia* **5** : 181, 183, figs. 1 (3, 4), 4 (19).

Notes. As suggested above, it is not impossible that the name *fasciatus* (F.W.) has priority over *jubatus*. The relation of *jubatus* to *muricatus* requires elucidation, and their differences may prove to be only subspecific.
Type locality. S.W. Siberia, Omsk province : Severnaya.

3. *Asiotmethis heptapotamicus* (Zubowsky 1898).

1898. *Eremobia muricata* var. *heptapotamica* Zubowsky, *Annu. Mus. zool. St. Petersb.* **3** : 103.
1905. *Eremobia stummeri* Kuthy, *Ann. Mus. nat. Hungar.* **3** : 217.
1926. *Tmethis heptapotamicus* Uvarov, *Konowia* **5** : 181, 184, figs. 6, 7.

Notes. The above synonymy has been established by Ikonnikov (1911, *Rev. russe Ent.* **11** : 360) and is correct.
Type locality. A number of localities in the Semiretchye (now Alma-Ata) province of Eastern Turkestan have been quoted by Zubowsky, and I select Iliysky poselok (or Iliysk) as the type locality of *A. heptapotamicus*; the type of *stummeri* was also from Iliysk.

4. *Asiotmethis turritus* (Fischer de Waldheim 1833), fig. 41.

1833. *Thrinchus turritus* Fischer de Waldheim, *Bull. Soc. imp. Nat. Moscou* **6** : 370.
1846. *Thrinchus muricatus* (partim !) Fischer de Waldheim, *Nouv. Mem. Soc. imp. Nat. Moscou* **8** : 260, ♂, pl. XI, fig. 3.
1846. *Thrinchus limbatus* Fischer de Waldheim, *loc. cit.* : 265 (*nec* Charpentier !).
1846. *Thrinchus cucullatus* Fischer de Waldheim, *loc. cit.* : 265 (**syn. n.**).

1876. *Eremobia biloba* Stål, *Bih. Sven. Akad. Handl.* **3** (14) : 35 (**syn. n.**).
1926. *Tmethis bilobus* Uvarov, *Konowia* **5** : 184, fig. 1 (5).
1932. *Eremobia biloba* Sjöstedt, *Ark. Zool.* **24A** (1) : 25, pl. 6, fig. 3.
1940. *Tmethis bilobus* Tarbinsky, *Saltat. Orth. Ins. Azerbaidzhan* : 212.

Notes. As the types of Fischer's species are missing, the above synonymy is based mainly on the assumption that there is only one species of the genus in Transcaucasia. It can scarcely be otherwise, since I have studied the Transcaucasian fauna for several years and have worked out extensive collections in the Tiflis Museum, without finding another species. Tarbinsky (1940, *loc. cit.*), after several years' personal work in eastern Transcaucasia, and after consulting all available literature, also recorded only one species. As regards the name of the species, the earliest one is *turritus* Fischer, which has been originally applied to an insect from Georgia, with the hind femur and hind tibia red (" coccinei "). The validity of the name has not been affected, of course, by the subsequent opinion of Fischer (1846, *loc. cit.*) that *turritus* should be united with *muricatus* Pall., an Asiatic species with violet legs. In the same year (1846), Fischer described an insect which he has called *limbatus* from specimens from Georgia and Verkhneudinsk in Transbaikalia. These specimens either belonged to two different species, or, more probably, the second locality was incorrect (similar mistakes occur repeatedly in Fischer's work, *e.g.*, in the case of *Psorodonotus venosus* F.W. described from Irkutsk, but actually a Caucasian endemic; see Ebner, 1923, *Konowia* **2** : 254). In any case, the identity of *limbatus* F.W. can be formally settled by restricting the application of the name to the insect from Georgia, which must be the same as *turritus*, and, of course, quite distinct from the Balkan *limbatus* Charp. The name *cucullatus* has been quoted by Fischer (1846, *loc. cit.*) as an unpublished synonym of his *limbatus*, but it is a valid name for *limbatus* F.W. (*nec* Charp.), since a description was given to the insect, and it must be ranged amongst synonyms of *turritus* F.W. The best-known name for the Transcaucasian insect is *bilobus* St., but it must now give way to *turritus* F.W.

Tarbinsky (1940, *loc. cit.*) states that he has never seen specimens of this species with a yellow edge to the pronotum. However, this colour form is not infrequent among the relatively small series before me.

Type locality. Although Fischer's original locality was " Georgie," this should not be taken to mean the present-day Georgia, where the species has never been found, being restricted to eastern parts of Azerbaidzhan. Indeed, in his description of *limbatus*, and elsewhere in the book, Fischer says " en Georgie, dans les steppes de Karabagh ", which means the Karabagh uplands in Azerbaidzhan, and this should be taken as the type locality for *turritus*, *limbatus* F.W. and *cucullatus*. Stål's *bilobus* has been described from Daghestan.

5. *Asiotmethis limbatus* (Charpentier 1842).

1842. *Eremobia limbata* Charpentier, *Orth. descr. depicta* : pl. 24.

Kirby (1910, *Syn. Cat. Orth.* **3** : 287) has synonymised this species with *Thrinchus accessorius* F.W. which, although a very little known insect, is certainly not even congeneric with *limbatus* (see p. 70).

Type locality. Turkey (probably in Europe).

6. *Asiotmethis heldreichi* (Brunner von Wattenwyl 1882).

Described originally as a *Glyphanus*, but clearly referable to *Asiotmethis* on the shape of elytra. Six narrowly localised subspecies have been dis-

tinguished by me (1934, *Eos* **10** : 106–111), and one is added below, but further studies are required to confirm their status, while new subspecies may be expected from the unexplored areas of Asia Minor.

6a. *Asiotmethis heldreichi heldreichi* (Brunner von Wattenwyl 1882).

1882. *Glyphanus heldreichi* Brunner von Wattenwyl, *Prodr. eur. Orth.* : 183, 184.

Type locality. Described from Athens and from Macedonia. I select Athens as the type locality.

6b. *Asiotmethis heldreichi escherichi* (Krauss 1896).

1896. *Eremobia escherichi* Krauss, *Zool. Jahrb., Syst.*, **9** : 565, pl. 8, figs. A–D.
1934. *Tmethis heldreichi escherichi* Uvarov, *Eos* **10** : 110, figs. 32E, 33E.

Type locality. Krauss quotes " Angora " (now Ankara), but Prof. Escherich collected in a wide neighbourhood of that town, and the exact locality of the type remains uncertain. I suggest, therefore, that the immediate vicinity of Ankara should be selected as the type locality.

6c. *Asiotmethis heldreichi adaliae* (Uvarov 1928).

1928. *Tmethis heldreichi adaliae* Uvarov, *Entom. Mitteil.* **17** : 176.
1934. *Tmethis heldreichi adaliae* Uvarov, *Eos* **10** : 111, figs. 32A, 33A.

Type locality. S.W. Anatolia: Adalia.

6d. *Asiotmethis heldreichi inermis* (Uvarov 1934).

1934. *Tmethis heldreichi inermis* Uvarov, *Eos* **10** : 110, figs. 32, I; 33, I.

Type locality. Northern slope of Kai-Dagh north of Changri on the road from Ankara to Kastamuni (see Uvarov, 1934, *loc. cit.* : 31).

6e. *Asiotmethis heldreichi ovipennis* (Uvarov 1934), figs. 35, 43.

1934. *Tmethis heldreichi ovipennis* Uvarov, *Eos* **10** : 111, figs. 32, O; 33, O.

Type locality. Beypazari, 75 km. N.W. of Ankara.

6f. *Asiotmethis heldreichi dimorphus* (Uvarov 1934).

1934. *Tmethis heldreichi dimorphus* Uvarov, *Eos* **10** : 109, fig. 33, D.

May be synonymous with *A. h. holtzi* (see below).

Type locality. Afyun-Karahissar.

6g. *Asiotmethis heldreichi holtzi* (Werner 1901).

1901. *Eremobia holtzi* Werner, *Sitz.-Ber. Akad. Wiss. Wien, mat.-nat. Cl.* **110** : 281.

Notes. Described from a single male and characterised mainly by the fully developed elytra in that sex. This is also the case in *T. h. dimorphus* and it is not improbable that the two will prove to be identical, in which case the name *holtzi* will have priority.

Type locality. Cilician Taurus.

7. **Asiotmethis pulchripes** sp. n.

1934. *Tmethis holtzi* Uvarov, *Eos* **10** : 111 (*nec* Werner !).

A re-examination of the specimens recorded by me as *holtzi* in 1934 has convinced me that they belong to an abundantly distinct new species, recognisable by the striking blue and red coloration of the inner face of the hind legs, relatively small size, strong sexual dimorphism in the organs of flight, and well-developed submarginal ridges of the pronotal metazona.

♂ (*type*). Face densely granulate; frontal ridge constricted below the ocellus. Fastigium of vertex relatively narrower than in other species of the genus; supraocellar foveola imperfectly marginated; preocellar foveola well impressed, but small; vertex with scattered granules and not strongly raised, irregular margins. Pronotum covered with dense acute tubercles. Prozonal carina strongly raised, trilobate; first lobe the longest, its upper edge straight in profile; second lobe tripartite above; third lobe small, triangular. Metazona triangular, with the apex parabolic, densely covered with tubercles; median carina scarcely perceptible; lateral carina distinct; submarginal carina very distinct, and regular, continued downwards along the hind margin of the lateral lobe; margins of the posterior angle distinctly laminate. Elytra as long as abdomen; wing a little shorter. Hind femur with both the lower and the upper carina strongly wavy.

Coloration pale greyish-ochraceous. Elytra practically devoid of pattern. Wing with the usual smoky fascia. Hind femur inside deep blue, with a reddish-yellow pregenicular fascia, a bright red patch at the base of the lower inner sulcus and a light reddish smear on the inner knee lobe, the base of which is deep blue. Hind tibia deep blue, gradually turning to bright-red in the apical third. Hind tarsus yellowish.

♀. Elytra strongly reduced, lateral, oval, reaching only the end of the first tergite. Abdomen above strongly rugose, with the median and the two sublateral series of sharp wrinkles.

Length of body ♂ 23, ♀ 35; pronotum ♂ 8, ♀ 9·5; elytra ♂ 16, ♀ 6; hind femur ♂ 13, ♀ 15 mm.

Type locality. Asia Minor: between Ankara and Tuz-Goel, 14.viii.1931, 4 ♂♂, 4 ♀♀ (*B. P. Uvarov*).

For notes on the habitat of this species, mistaken by me at that time for *A. holtzi*, see *Eos* **10** : 33.

8. *Asiotmethis zacharjini* (Bey-Bienko 1926).

1926. *Tmethis zacharjini* Bey-Bienko, *Izvest. zap.-sibir. Otd. geogr. Obstch.* **5** : 202, fig. 2.
1926. *Tmethis zacharjini* Uvarov, *Konowia* **5** : 181, 185, figs. 2 (10, 11).
1929. *Tmethis zacharjini* Bey-Bienko, *Trudy sibir. Inst. sel. Khoz. Lesov.* **13** : 18.

Notes. In his later paper Bey-Bienko (1929) stated that this species appeared to be widely distributed over the northern part of the Turanian region, but actually there are no valid records of it from anywhere except the immediate neighbourhood of Lake Zaisan, since it was Bey-Bienko himself (1926, 1930, *Izv. Zap.-Sib. Georgr. Obstch.* **7** : 20) who assigned several other records to *A. jubatus*. It is not impossible, therefore, that *A. zacharjini* might represent merely a narrowly localised subspecies of *A. muricatus*. On the other hand, its relation to the following species remains obscure.

Type locality. Eastern Kazakhstan, Lake Zaisan: Topolev Mts.

9. *Asiotmethis serricornis* (Fischer de Waldheim 1846).

1846. *Thrinchus serricornis* Fischer de Waldheim, *Nouv. Mem. Soc. imp. Nat. Moscou* **8** : 264.

Notes. The description of this insect might be sufficient for its specific

recognition if its original locality were exactly known and a possibility existed of comparing the description with the species actually occurring in that locality. Fischer records it as having been taken in " les steppes des Kirguises " by Schrenk. According to Lipsky (1902–1905, *Trudy Tiflis. bot. Gard.* **7** : 221–223; 269–272; 557–558), A. Schrenk, who was mainly a botanist, travelled in 1840–43 over wide areas in the present eastern Kazakhstan. The region covered by Schrenk's routes (fully listed by Lipsky, *loc. cit.*) lies roughly between the line Omsk–Sergiopol in the north; Lake Balkhash and the Alatau mts. in the south; River Sary-su in the west; and western Dzhungaria (Barlyk mts., Chuguchak, southern slopes of the Tarbagatai mts.) in the east. It is a vast region, with a great diversity of conditions, and several species of *Asiotmethis* should occur there, though actual records are scanty and unreliable. It is not impossible that more definite information as to the localities of insects collected by Schrenk might be found in his manuscript catalogues entitled " Insecta songorica " which are preserved in the Leningrad Botanical Garden according to Lipsky (*loc. cit.* : 558, footnote).

Among the few definite characters found in the description of *A. serricornis*, the red hind tibia suggests its similarity to *A. heptapotamicus* and *A. zacharjini*, and the last-named species approaches *A. serricornis* in the pronotum being generally less rugose than in *A. muricatus*, while in the other it is usually more so. Therefore, some evidence exists that *A. zacharjini* may be a synonym of *A. serricornis*, but there is a geographical objection to this, because Schrenk, in all his travels, never visited the depression of Lake Zaisan, and *A. zacharjini* has not yet been found outside the depression.

It appears best, therefore, to retain *A. serricornis* tentatively as a separate species in the hope that further investigations will solve the problem of its identity.

Type locality. See the area of Schrenk's travels defined above.

10. *Asiotmethis transiens* (Uvarov 1925).

1925. *Tmethis transiens* Uvarov, *Journ. Bombay nat. Hist. Soc.* **30** : 269.
1926. *Tmethis transiens* Uvarov, *Konowia* **5** : 181, 185, fig. 2 (8, 9).

Notes. Although the metazona of pronotum is less distinctly lamellate than in other species of the genus, there are no other characters suggesting that it is not congeneric with them.

Type locality. Ferghana Province (now Tadzhikistan): Vuadil.

GLYPHANUS Fieber 1853.

1853. *Glyphanus* Fieber, *Lotos* **3** : 128.

Genotype: *Glyphanus obtusus* Fieber 1853, the only species originally included.

Notes. Differences between this genus and *Asiotmethis* are few and depend almost entirely on the extreme reduction of the organs of flight, the elytra being reduced in both sexes to narrow, perfectly lateral and very widely separated pads (fig. 44), while the wings are completely absent. A reduction of elytra, to the extent of becoming lateral and dorsally separated from each other, occurs also in the genus *Asiotmethis*, e.g. in some subspecies of *A. heldreichi*, but they remain broadly oval and widened behind the middle (fig. 43), while the rudiments of hind-wings are not, or scarcely, shorter than the elytra. Other characters of *Glyphanus* are all correlated with winglessness and found

in the species and subspecies of *Asiotmethis* with lateral elytra. Thus, the absence of serration on the middle tibia is observed in the females of several subspecies of *A. heldreichi*, and of *Pezotmethis crassus*, etc., as well as in both sexes of *A. heldreichi ovipennis*. Similarly, the lowering of the prozonal carina and the shortening of the metazona which becomes widely rounded behind, while very typical for *Glyphanus*, occur again in the strongly brachypterous species, subspecies and sexes of *Asiotmethis* and in the genus *Pezotmethis*. The genus *Glyphanus* remains, therefore, based on a single character of the extreme reduction of the flight organs, but there is a clear discontinuity between a series of species of *Asiotmethis* with progressively shortened but broad elytra and with wings, and the completely wingless *Glyphanus* with narrow elytra, and the two genera can be regarded as distinct, at least until clearly transitional forms are found. The alternative would be to include the numerous species of *Asiotmethis* into *Glyphanus*, with the most aberrant *G. obtusus* as the genotype, an obviously unsatisfactory solution.

The genus, as re-defined above, contains one species only, since *Glyphanus heldreichi* Br. W. is an *Asiotmethis* (see p. 55).

1. *Glyphanus obtusus* Fieber 1853, figs. 11, 44.

1853. *Glyphanus obtusus* Fieber, *Lotos* **3** : 129.

Type locality. Rumelia.

Pezotmethis gen. n.

Genotype : *Eremobia tartara* Saussure 1884.

Diagnosis: Closely allied to *Asiotmethis*, differing in the less rugose and less pilose body, strongly abbreviated organs of flight in both sexes, and particularly in the posterior margin of pronotum being not laminate but incrassate, as well as in the structure of the epiphallus (fig. 32).

Notes. I am unable to regard the species which form this genus as merely brachypterous members of *Asiotmethis*, since the differences in the pronotal structure and in the epiphallus are of very definite character. These differences are, moreover, not connected with brachypterism, since short-winged species of *Asiotmethis* such as *A. heldreichi* still have the pronotum typical for the genus.

Key to species, see Uvarov 1926 (*Konowia* **5** : 182–183), but all references to figures given there are incorrect; correct references are quoted under the respective species below.

1a. *Pezotmethis tartarus tartarus* (Saussure 1884), fig. 32.

1884. *Eremobia tartara* Saussure, *Prodr. Oedip.* : 226, 229.
1926. *Tmethis tartarus* Uvarov, *Konowia* **5** : 182, 185, fig. 3 (14).

Type locality. Turkestan.

1b. *Pezotmethis tartarus montanus* (Uvarov 1925).

1925. *Tmethis tartarus montanus* Uvarov, *J. Bombay nat. Hist. Soc.* **30** : 269.

Type locality. Tchatkal mts., Tashkent district.

2. *Pezotmethis karatavicus* (Uvarov 1912).

1912. *Tmethis bilobus karatavicus* Uvarov, *Rev. russe Ent.* **12** : 212.
1926. *Tmethis karatavicus* Uvarov, *Konowia* **5** : 182, 185.

Type locality. Syr-Darja province : Bala-Murun in the Karatau mts.

3. *Pezotmethis nigrescens* (Pylnov 1914).

1914. *Tmethis nigrescens* Pylnov, *Rev. russe Ent.* **14** : 107, fig. 2.
1926. *Tmethis nigrescens* Uvarov, *Konowia* **5** : 182, 185, fig. 3 (15).

Type locality. Tchimkent district.

4. *Pezotmethis pylnovi* (Bey-Bienko 1941).

1941. *Tmethis pylnovi* Bey-Bienko, *Mem. Inst. agron. Leningrad* **4** : 156.

Type locality. N. Turkestan, Kurpesh, 1100 mts., in the Karatau mts.

5. *Pezotmethis ferghanensis* (Uvarov 1925).

1925. *Tmethis ferghanensis* Uvarov, *J. Bombay nat. Hist. Soc.* **30** : 270.
1926. *Tmethis ferghanensis* Uvarov, *Konowia* **5** : 182, 186, fig. 3 (16).

Type locality. Ferghana province : Ashaba.

6. *Pezotmethis crassus* (Uvarov 1925).

1925. *Tmethis crassus* Uvarov, *J. Bombay nat. Hist. Soc.* **30** : 271.
1926. *Tmethis crassus* Uvarov, *Konowia* **5** : 183, 186, fig. 3 (17).

Type locality. Syr-Darja prov., Aulie-Ata distr. : Berkara.

Melanotmethis gen. n.

Genotype : *Eremobia fuscipennis* Redtenbacher 1889.

Diagnosis: Superficially very similar to *Eremocharis*, mainly because the pronotal metazona is acutangular, with thick, straight sides, but differs from it in the frontal ridge, which is not compressed; fastigium of vertex broadly rounded, not angularly projecting forward, its surface not forming an angle with the lateral slopes; upper and lower carina of hind femur not wavy; and hind-wing black except apically. From *Asiotmethis*, which *Melanotmethis* resembles in the general habitus, it differs by the structure of vertex; by non-laminate and acutangular metazona of pronotum; by the well-developed subtympanal lobe; and by the shape of the hind femur. A close affinity in the structure of pronotum is observed between *Melanotmethis* and *Pezotmethis*, but species of the latter have a very small subtympanal lobe (as in *Asiotmethis*, see fig. 29) and are flightless in both sexes. Epiphallus (fig. 37) is provided with a flat trapezoidal apical projection.

1. *Melanotmethis fuscipennis* (Redtenbacher 1889), figs. 3, 37.

Subspecific differences in this species appear to be found mainly in the coloration of hind legs, but Redtenbacher's original description was probably based on discoloured specimens, since he says "*tibiae posticae concolores*," that is of the general body colour. In addition, the type locality was indicated as merely "Turcomania." In the absence of other evidence, I had to follow Zubowsky's (see below) interpretation of the typical subspecies.

1a. *Melanotmethis fuscipennis fuscipennis* (Redtenbacher 1889).

1889. *Eremobia fuscipennis* Redtenbacher, *Wien. ent. Ztg.* **8** : 24, 28.
1896. *Eremobia fuscipennis* Zubowsky, *Horae Soc. ent. ross.* **30** : 187.
1926. *Tmethis fuscipennis* Uvarov, *Konowia* **5** : 181, 185, fig. 2 (13).

Diagnosis: Hind tibia blue, except the base, which is of body colour, and the apical quarter, which is red.

Type locality. The vague original indication "Turcomania" would cover Uzun-Ada, near Krasnovodsk, whence Zubowsky's specimen was obtained, and I propose to regard this as the type locality.

1b. *Melanotmethis fuscipennis unicolor* (Uvarov 1933).

1933. *Tmethis fuscipennis unicolor* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 213.

Diagnosis: Hind tibia uniformly purple.

Type locality. Northern Iran, Khorasan province: Buzhnurt.

TMETHIS Fieber 1853.

1839. *Eremobia* Serville, *Ins. Orth.* : 704 (preoccupied by *Eremobia* Stephens 1829).
1853. *Tmethis* Fieber, *Lotos* **3** : 128.

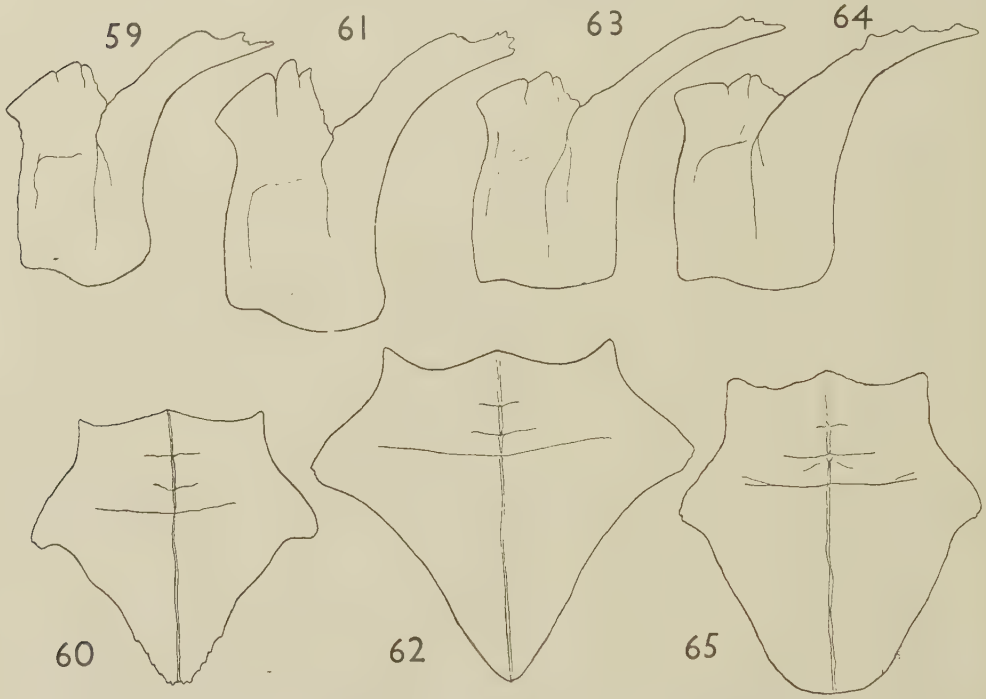
Genotype: *Gryllus cisti* Fabricius 1787; selected by Kirby (1910, *Syn. Cat. Orth.* **3** : 285).

Diagnosis. Body distinctly laterally compressed, particularly in the male, rugulose and tuberculate, hairy. Head in frontal view as wide as high. Frontal ridge strongly compressed, deeply sulcate, narrow, gradually widened below, with a weak transverse septum above the ocellus, which is placed distinctly below the line connecting the lower edges of the eyes. Vertex not more than twice the width of an eye, strongly projecting forward and sloping; concave, with a narrow median sulcus; the strongly raised outer margins form a scutellum which is incompletely closed behind. Supraocellar foveola placed on the almost vertical outer slope of the raised fastigial margin, elongate, very weakly defined, only the lower margin being clearly distinct; preocellar foveola absent or merely indicated by a weak depression under the edge of fastigium near its apex. Pronotum with the median carina in the prozona tectiform and tripartite; in the metazona always distinct and usually well raised; metazona convex in cross-section, as long as it is wide, and somewhat longer than the prozona. Prosternum with weakly reflexed front margin. Abdominal organ well developed, weakly wrinkled and tuberculate. Tympanum sunken, half covered by large subtympanal lobe. Elytra well developed to moderately reduced. Wings with the second axillary vein strongly sinuate; disc usually rose coloured; dark fascia not sharply defined and often interrupted, with a more or less distinct radial branch. Epiphallus (figs. 34, 36, 38, 39) with the apical part projecting and distinctly bilobate.

Notes. The difficulties in the specific classification within the genus are made particularly great by the frequent occurrence, in probably all species, of variation in the sculpturing of the integument, and in the development of the pronotal carina (see p. 35). The smooth f. *laeviuscula*, or the low-crested f. *incristata*, of any species look very different from the more normal forms and in the past there was a tendency to regard such differences as specific. Indeed, it is difficult to believe that f. *incristata* (fig. 63) of *T. cisti clavelii* is conspecific with the high-crested form (fig. 61) of the same species, but the figures are based on two insects taken at the same place and on the same day, and almost

every sufficiently long series of specimens includes both forms. It was, therefore, impracticable to use these characters in the following revision, and more reliable specific criteria have been found in the structure of the pronotal metazona, hind legs, male epiphallus, and female ovipositor, while for separating subspecies the coloration of the hind legs and, sometimes, of the hind-wings was found of value.

As restricted now, the genus *Tmethis* would include four of the " species "



Figs. 59–65.—Male pronotum. 59–60, *Tmethis pulchripennis pulchripennis*. 61–62, *T. cisti clavelii*. 63, do., f. *incristata*. 64–65, *T. maroccanus hirtus*.

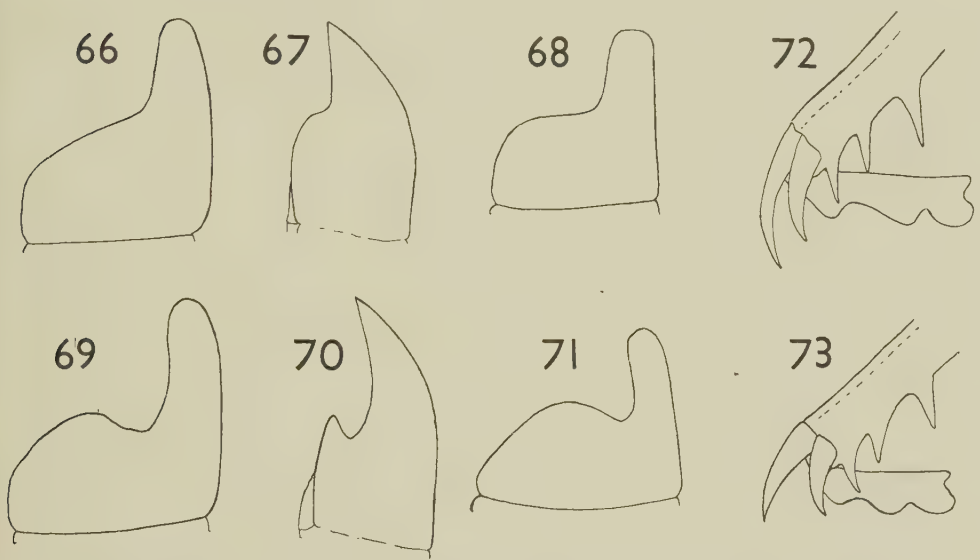
recognised by Kirby (1910, *Syn. Cat. Orth.* **3** : 288–289, 582) and the eight additional names regarded by him as synonyms or " varieties." Since then two subspecies of *T. cisti* have been described, namely *T. c. harterti* Uvarov 1923 and *T. c. barcaeus* Salfi 1926. Thus, not fewer than fourteen previously described nominal forms must be subjected to a revision. A fully critical revision is not possible without much more abundant material than is available at the moment, and the following arrangement of species and subspecies is merely an attempt to bring some order out of the present chaos. Only three species are recognised by me, but it is probable that their number is greater, while a large number of more or less clearly defined geographical subspecies may be expected to merit recognition. Their critical study on extensive material, especially when combined with field observations on the distribution and ecology, promises to throw much light on the biogeography of North Africa, as well as on the general problems of geographical and ecological variation.

Key to the species.

1 (4). Metazona of pronotum triangular, with the sides straight, or even somewhat incurved (figs. 60, 62).

2 (3). Male epiphallus with the apical lobes relatively small, and narrowly separated (figs. 34, 36). Lower valve of ovipositor with a distinct "shoulder" (figs. 69, 71) which appears as a tooth in the lateral aspect (fig. 70). Spurs of hind tibia relatively shorter and stouter; first tarsal joint short, its second pulvillus not longer than the first or the third (fig. 73) . . . . . 2. *T. pulchripennis.*

3 (2). Male epiphallus with apical lobes large, broadly separated (figs. 38, 39). Lower valve of ovipositor without a projection (figs. 66, 68), not dentate in lateral aspect (fig. 67). Spurs of hind tibia long and slender; first tarsal joint long, its second pulvillus longer than the first or third (fig. 72) . . . . . 1. *T. cisti.*



FIGS. 66–73.—66, *Tmethis cisti clavelii*, right lower valve of the ovipositor, ventral view. 67, do., side view. 68, *T. cisti gracilis*, do., ventral view. 69, *T. pulchripennis asiaticus*, do., ventral view. 70, do., side view. 71, *T. pulchripennis pulchripennis*, do., ventral view. 72, *T. cisti clavelii*, ♀, apex of hind tibia and first tarsal joint. 73, *T. pulchripennis asiaticus*, do.

4 (1). Metazona of pronotum broadly parabolic, with the margins convex (fig. 65). Male epiphallus, ovipositor and hind legs as in *T. cisti* 3. *T. maroccanus.*

1. *Tmethis cisti* (Fabricius 1787), figs. 6, 30, 38, 39, 61–63, 68, 72.

1787. *Gryllus cisti* Fabricius, *Mant. Insect.* **1** : 237.
1791. *Acrydium cisti* Olivier, *Encycl. meth., Hist. nat. Ins.* **6** : 222.
1805. *Acridium hispidulum* Palisot de Beauvois, *Ins. Afr. Amer.* : 200, Orth. pl. 5, fig. 5.
1813. *Gryllus Locusta versicolor* Stoll, *Repres. Spectres, Saut.* etc. : 34, pl. 18 b, fig. 66 (syn. n.).
1910. *Tmethis olivieri* Kirby, *Syn. Cat. Orth.* **3** : 288 (syn. n.).

Notes. A great deal of unnecessary confusion regarding this species has occurred through the lack of direct indication of the original locality by Fabricius. His original description was followed only by the statement "*Habitat in*

Cisto halimifolio. Dom. Vahl," without any reference to the country. In the preface to the book, Fabricius (1787, *loc. cit.* : v) has given a list of his collectors and of the countries from which they brought him insects, and there one may read " Vahl Hispanica, Barbarica . . ." Thus, *Gryllus cisti* might be either a Spanish, or a North African, insect. Olivier (*loc. cit.*), who has merely translated Fabricius' Latin description into French, must have looked at the preface but did not notice the alternative locality and has recorded the species as occurring only in Spain. Since then the name has been repeated in all lists of the Spanish fauna, but the insect has not been recorded from that country (I. Bolivar 1898, *Ann. Sci. nat. Porto* **5** : 25) except on the basis of old specimens with doubtful labels (cf. Brunner v. Wattenwyl 1882, *Prodr. eur. Orth.* : 183). It is apparent, therefore, that Vahl collected his specimens in northern Africa. At the end of the eighteenth century Algeria was still very hostile and the only part of northern Africa accessible to European travellers was Tunisia. In fact, Martin Vahl, who was a pupil of Linné and primarily a botanist, travelled in the north of Tunisia in 1783 (Cosson 1881, *Compend. Florae Atlant.* **1** : 10) and this must be considered as the country of origin of *Gryllus cisti*. My efforts to assign the type locality more precisely are without success. Fabricius has mentioned that the type was found in association with *Cistus halimifolius* L. (now *Helianthemum halimifolium*), but this plant is fairly widely spread in the western Mediterranean countries, and Vahl's own record of it (Vahl 1790, *Symb. botan.* **1** : 38) is merely : " Specimina numerosa in Barbaria observata."

Saussure (1888, *Addit. Prodr. Oedip.* : 129, footnote) was responsible for further confusion by suppressing the name *cisti* F. which he thought equally applicable to any species of the rose-winged group and probably based on Syrian or Egyptian specimens; a statement showing merely that Saussure did not look at the preface to Fabricius' book. Still worse, Saussure (*loc. cit.* : 131) has accepted the name *cisti* Ol. for the species supposed to occur in Spain and Algeria, though known to him only from the latter country. Kirby (*loc. cit.*) realised that Saussure's action was incorrect from the nomenclatural point of view, and restricted the name *cisti* F. to a species from Egypt, Tunis and Syria, while proposing a new name, *olivieri* Kirby, to replace " *Acrydium cisti* pt. Oliv. (*nec* Fabr.)," the distribution of which was given as " Spain?, Algeria." As is shown above, Olivier never described a species distinct from that of Fabricius but did narrow down the specific concept by quoting Spain as the only locality. Therefore, it was quite impossible to suggest, as Kirby did, that Olivier's description referred to two species, and to re-name one of them. Accordingly, *T. olivieri*, as based on nothing but Olivier's translation of the Fabrician diagnosis, is a pure synonym of *cisti* F.

Both *Acridium hispidulum* Palisot de Beauvois and *Gryllus Locusta versicolor* Stoll are known only from poor descriptions, without any indication of the country of origin, and from unsatisfactory figures, and are referred as specific synonyms to *cisti* because of the colour of the hind tibiae ; it is hopeless to attempt to assign the names to any subspecies.

The changes in the application of the name *cisti* F. introduced by Saussure and Kirby have caused such confusion that it is hardly possible now to assign records of subsequent authors to the proper taxonomic units without re-examining the original material. Therefore, the above list of specific synonyms, as well as the lists under subspecies, comprise only the references to distinct published names.

1a. *Tmethis cisti cisti* (Fabricius 1787).

1787. *Gryllus cisti* Fabricius, *Mant. Insect.* **1** : 237.

The typical subspecies is characterised by the sanguineous hind tibia; hind femur on the inside also sanguineous on the edges, with a large blue-black spot. Elytra longer than abdomen.

Type locality. Northern Tunisia (see above).
Distribution. Known to me from Tunisia: Gafsa, Kairouan, El Djem. E. Algeria: El Gherra, south of Constantine; Biskra, Djelfa, Touggourt. Appears to be proper to eastern Algeria and to the inland dry areas of Tunisia.

1b. *Tmethis cisti tunensis* (Saussure 1888), fig. 39.

1888. *Eremobia clavelii* var. *tunensis* Saussure, *Addit. Prodr. Oedip.* : 131.
1902. *Eremobia cisti* Vosseler, *Zool. Jahrb., Syst.*, **16**, pl. 3, figs. 1, 2.

A robust form, with the elytra somewhat abbreviated, especially in the female; hind tibia bright red; hind femur on the inside pale yellow, with blue-black spot.

Type locality. Tunisia, coastal dunes.
Distribution. Known to me from St. Germain near Tunis, and Gafsa.

1c. *Tmethis cisti gracilis* (Saussure 1888), fig. 68.

1888. *Eremobia clavelii* var. *gracilis* Saussure, *Addit. Prodr. Oedip.* : 131.
1902. *Eremobia cisti* var. *gracilis* (?) Vosseler, *loc. cit.* pl. 3, figs. 14, 20d.

Small and relatively slender; hind tibia almost entirely dark-blue, reddish only apically; inside of hind femur dark-blue.

Type locality. Tunisia.
Distribution. Gabes is the only definite locality quoted by Vosseler.

1d. *Tmethis cisti clavelii* (Lucas 1851), figs. 38, 61–63, 66, 67.

1851. *Eremobia clavelii* Lucas, *Ann. Soc. ent. Fr.* (2) **9** : 364, pl. 8, figs. 1–1 g.
1888. *Eremobia clavelii* var. *algerica* Saussure, *Addit. Prodr. Oedip.* : 131 (**syn. n.**).
1902. *Eremobia cisti* Vosseler, *loc. cit.*, pl. 3, figs. 3–12, 20a, b, c.

A fairly large, but relatively slender and long-winged form; hind tibia yellow to light orange-red; hind femur on the inside yellow, with bluish-black spot.

Type locality: Algeria. Boghari.
Distribution. Algeria: Ain-Sefra; Tiout, E. of Sefra; Bou-Saada; Djelfa. This subspecies appears to be proper to the western parts of southern Algeria, meeting at Djelfa with *T. cisti cisti*.

1e. *Tmethis cisti mozabitica* (Krauss 1902).

1902. *Eremobia claveli* var. *mozabitica* Krauss, *Verh. zool.-bot. Ges. Wien* **52** : 244.
1902. *Eremobia cisti* var. *mozabitica* Vosseler, *loc. cit.* : 386, pl. 3, figs. 18, 19.

Similar to *E. c. clavelii* in the habitus, but hind-wings bluish instead of rose; hind tibia and the inside of hind femur yellow, the latter with blue-black spot.

Type locality. Southern Algeria: Ghardaia (selected here).
Distribution. This is the southernmost subspecies, known only from the Mzab country (Ghardaia, Ouargla, El Alia).

1f. *Tmethis cisti barcaeus* Salfi 1926.

1926. *Tmethis cisti barcaeus* Salfi, *Arch. zool. ital.* **2** : 86, 90, fig. 6a, pl. 5, fig. 47.

Not known to me by specimens; appears to be characterised by yellow hind tibia, and reddish-purple inside of hind femur, without a black spot, as well as by hyaline wings.

Type locality. Cyrenaica : Benghasi.

1g. *Tmethis cisti harterti* Uvarov 1923.

1923. *Tmethis cisti harterti* Uvarov, *Novit. zool.* **30** : 73.
1926. *Tmethis cisti harterti* Salfi, *loc. cit.* : 81, 90, figs. 6b, 6c; pl. 4, figs. 38, 39; pl. 5, figs. 44, 45, 46.

Brachypterous, particularly in the female sex; wings faintly bluish; hind tibia uniformly sanguineous; inside of hind femur vinaceous-red, darker towards the base but without a definite spot.

Type locality. Cyrenaica : Merg.

Distribution. Recorded by Salfi (*loc. cit.* and 1925, *Boll. Soc. Nat. Napoli* **37** : 93), from Tolmetta, Merg, Tecnis, Benghasi, Tocra, Apollonia and Cyrene.

2. *Tmethis pulchripennis* (Serville 1838), figs. 14, 21, 34, 36, 59, 60, 69–71, 73.

1838. *Eremobia pulchripennis* Serville, *Suite à Buffon, Ins. Orth.* : 708.

The characters of this species have been given in the key above (p. 63), and they appear to be sufficient for its specific separation from *T. cisti*, but it must be remembered that no *Tmethis* has been studied from the whole of Tripolitania, nor from the Libyan coast between Cyrenaica and Alexandria, where transitional forms may eventually be found.

2a. *Tmethis pulchripennis pulchripennis* (Serville 1838), figs. 34, 59, 60, 71.

1838. *Eremobia pulchripennis* Serville, *loc. cit.* : 708.

The Egyptian subspecies is smaller than the next one and is characterised by the hind tibia and the edges of the inside of hind femur being light-red; the femur is with black spot.

Type locality. Egypt.

Distribution. Known to me from Mariout and Abouqir (both on the west side of the Nile); it remains to be seen whether the same subspecies occurs on its eastern side.

2b. **Tmethis pulchripennis asiaticus** subsp. n., figs. 14, 21, 36, 69, 70, 73.

Specimens of *T. pulchripennis* from Palestine, Syria, Southern Turkey and Iraq are characterised by the hind tibia and the edges of the inside of hind femur light being yellow, the femur bearing the usual bluish-black spot. There is a great resemblance between this subspecies and *T. cisti clavelii*, but they differ well in the specific characters (see key, p. 63).

Type locality. Palestine : Khedeira.

Distribution. Palestine : Khedeira, 30.v.1921, 4 ♂♂ (including the type), 1 ♀; Huleh, Galilee, 24.v.1922, 1 ♂; Bittir, 23.v.1922, 1 ♂, 1 ♀; Jerusalem, 26–27.iv.1922, 1 ♂, 1 ♀; 10 m. E. of Jerusalem, 17.iv.1922, 1 ♂, 1 ♀; Jericho, 11.iv.1923, 1 ♂, 2.v.1923, 1 ♀; Jordan valley, Kokabal Hama, 8.iv.1922, 1 ♂;

Tel Arad, S. Palestine, 21.v.1923, 1 ♂, 1 ♀; Beersheba, Ksaifeh, 12.v.1922, 2 ♀♀ (all *P. A. Buxton*); East of Hebron to Ein Jadi, v.1934, 1 ♀ (*O. Theodor*); Jaffa, 1 ♀ (*Seabrook*); Km. 22, road from Jerusalem to Jericho, 13.v.1932, 1 ♀ (*B. P. Uvarov*); Wadi Gaza, 1 ♀ (*F. Waird*); Jerusalem, 1 ♂, 2 ♀♀ (*Zeuner* collection). TRANSJORDAN: Amman, 2 ♂♂, 1 ♀; Zarqa, 24.iv.1923, 1 ♀ (*H. St. J. Philby*). SYRIA: 40 miles around Aleppo, iv.–vii.1919, 1 ♂, 2 ♀♀ (*F. G. Aldous*). SOUTH TURKEY: Urfa and environs, vii.1931, 3 ♂♂, 5 ♀♀ (Eshref Bey). IRAQ: Arbil district, Zirga Zarow hills, 31.v.1923, 1 ♂ (*B. P. Uvarov*). PERSIA: Luristan, Qasr-i-Shirin, 30.iv.1914, 1 ♀ (*P. V. Nesterov*); Kermanshah prov., Harun Abade, 2 ♀♀ nymphs (*Afshar*).

Specimens from the southernmost desert areas of Palestine are mostly of the f. *laeviuscula* and f. *incristata* (see p. 35), while those from the hills are much more strongly sculptured. It is not impossible that the variation of the integument in this case is geographical or ecological, but this should be studied on the spot.

3. *Tmethis maroccanus* I. Bolivar 1908, figs. 64, 65.

1908. *Tmethis maroccanus* I. Bolivar, *Bol. Soc. esp. Hist. nat.* **8**: 326.
1929. *Tmethis maroccana* Werner, *Sitz.-ber. Akad. Wiss. Wien, Mat. nat. Kl.* **138**: 180, pl. IV, fig. 11.

This species is not known to me in its typical subspecies, but I think I am right in referring to it a new subspecies and judging the specific characters on its basis. It agrees with *T. cisti* in the structure of the epiphallus, ovipositor and hind legs, but differs strikingly in the shape of the pronotal metazona, as well as in the tendency to a very diffused and irregular elytral pattern.

3a. *Tmethis maroccanus maroccanus* I. Bolivar, 1908.

1908. *Tmethis maroccanus* I. Bolivar, *loc. cit.*: 326.

The typical subspecies is said to be characterised by the female elytra not reaching the hind knee, and by the yellow colour of the hind tibia and the inside of hind femur which has a blue spot. It is known also in f. *incristata*.

Type locality. Morocco: Marrakesh.

3b. **Tmethis maroccanus hirtus** subsp. n., figs. 64, 65.

Hind tibia and the inside of hind femur vary from bright-red to dark-red; femur with a black-red spot, often imperfectly defined; edges of body and all legs with unusually dense and long hairs.

Type locality. S. Western Algeria: Colom-Bechar.

Distribution. ALGERIA: Oran, Colom-Bechar, 26–29.iv.1923, 9 ♂♂ (including the type), 5 ♀♀, 10 nymphs (*A. Cros*); Beni Ounif de Figuig, 1 ♂ (*A. Cros*). E. MOROCCO: Talialit, 1 ♂, 3 ♀♀ (*A. Thery*); Midelt, 2.vi.1934, 1 ♂ (*Rungs*).

The specimens from the Moroccan Atlas are less hirsute than those from the Oran desert and may deserve to be treated as a distinct subspecies.

FILCHNERELLA Karny 1908.

1908. *Filchnerella* Karny in Attems: *Filchner Exped. China–Tibet, zool.-bot. Ergebn.* **1**: 36.

Genotype: *Filchnerella pamphagoides* Karny 1908, the only species originally included.

Diagnosis. See Karny (1908).

Notes. In the structure of the head, *Filchnerella* is closely similar to *Tmethis* (as restricted in the present paper), but clearly differs from it in the short, obtusangulate pronotal metazona, armed with submarginal spines; in the structure of the anterior prosternal margin; in the shape of hind femur etc.

1. *Filchnerella pamphagoides* Karny 1908.

1908. *Filchnerella pamphagoides* Karny, *loc. cit.* : 40, pl. I, figs. 9–12; pl. II, figs. 20–24.
1923. *Filchnerella pamphagoides* Chang, *China J. Sci.* **1** (5) : 486–494.

Type locality. China : Lan-tschou.

2. *Filchnerella beicki* Ramme 1931.

1931. *Filchnerella beicki* Ramme, *Mitt. zool. Mus. Berlin* **17** : 446, figs. 1–4.

Type locality : China : Kansu province, Liangchow district, Daho valley, 1700 m.

RHINOTMETHIS Sjöstedt 1933.

1933. *Rhinotmethis* Sjöstedt, *Ark. Zool.* **25A** (3) : 29.

Genotype : *Rhinotmethis hummeli* Sjöstedt, the only species originally included.

Diagnosis. See Sjöstedt (1933).

Notes. Ramme (1939, *Mitt. zool. Mus. Berlin* **24** : 135) proposed to regard this genus as synonymous with *Filchnerella*, from which it appears to differ only in the specialised frontal ridge. The difference, however, is so considerable that Ramme's view cannot be accepted, at any rate until some species is discovered showing an intermediate degree of specialisation.

1. *Rhinotmethis hummeli* Sjöstedt 1933, fig. 22.

1933. *Rhinotmethis hummeli* Sjöstedt, *loc. cit.* : 29, pl. 11, figs. 7, 8; pl. 12, figs. 1, 2.

Type locality. Southern Mongolia : Talen Gashat, 1350 m.

UTUBIUS Uvarov 1936.

1936. *Utubius* Uvarov, *Linn. Soc. J., Zool.* **39** : 544.

Genotype : *Utubius zahrae* Uvarov 1936.

Diagnosis. See Uvarov 1936.

Note. One species, with an additional subspecies, is so far known.

1a. *Utubius syriacus syriacus* (I. Bolivar 1893).

1893. *Eremocharis syriaca* I. Bolivar, *Rev. biol. N. France* **5** : 483.
1938. *Utubius syriacus syriacus* Uvarov, *Field Mus. nat. Hist., Zool.* **20** : 447, figs. 60a, 60b.

Type locality. Syria : Palmyra.

1b. *Utubius syriacus zahrae* Uvarov 1936.

1936. *Utubius zahrae* Uvarov, *Linn. Soc. J., Zool.* **39** : 544, pl. 11, fig. 3.
1938. *Utubius syriacus zahrae* Uvarov, *Field Mus. nat. Hist., Zool.* **20** : 448, figs. 60c, 60d, 60e.

Type locality. N.E. Arabia : Kuwait.

THRINCHUS Fischer de Waldheim 1833, figs. 13, 31, 50.

1833. *Thrinchus* Fischer de Waldheim, *Bull. Soc. imp. Nat. Moscou* **6** : 363, 378.
1846. *Thrinchus* Fischer de Waldheim, *Nouv. Mem. Soc. imp. Nat. Moscou* **8** : 228, 255 (partim !).
1853. *Thrinchus* Fieber, *Lotus* **3** : 128.
1884. *Thrincus* Saussure, *Prodr. Oedip.* : 61, 219.
1888. *Thrincus* Saussure, *Addit. Prodr. Oedip.* : 94.

Genotype : *Thrinchus campanulatus* Fischer de Waldheim 1833, the only original species of the genus.

Diagnosis. See Saussure 1884 (*loc. cit.*), 1888 (*loc. cit.*). Epiphallus (fig. 31) elongate, with a parabolic apical projection.

Notes. Species of this genus are still very insufficiently known and the attempts at partial revisions made by Ikonnikov (1911, *Rev. russe Ent.* **11** : 359) and by Tarbinsky (1926, *Ann. Mag. nat. Hist.* (9) **17** : 91) cannot be considered quite satisfactory, since neither author paid sufficient attention to establishing the specific characters of Fischer's two species. Ikonnikov's key to these two species appears to contradict the original descriptions and figures, and it is not improbable that his use of Fischer's names should be reversed. Tarbinsky has described two new species and produced a key to all four, but it is uncertain on what material he based his conceptions of Fischer's species. The material before me, although fairly abundant, is still considered insufficient for a serious revision, and the following list of known species is a tentative one. The existence of undescribed species in Eastern Middle Asia is very probable.

1. *Thrinchus campanulatus* Fischer de Waldheim 1833.

1833. *Thrinchus campanulatus* Fischer de Waldheim, *Bull. Soc. imp. Nat. Moscou* **6** : 376.
1846. *Thrinchus campanulatus* Fischer de Waldheim, *Nouv. Mem. Soc. imp. Nat. Moscou* **8** : 257, pl. XI, fig. 1.

Notes. As stated above, it is not certain whether Ikonnikov's (1911, *loc. cit.*) and Tarbinsky's (1926, *loc. cit.*) interpretations of this and the following species were correct. The same remark applies to Saussure's redescription (1884, *Prodr. Oedip.* : 221).

Type locality. Fischer has indicated Georgia in Transcaucasia as the original locality, but this is definitely incorrect, and the types must have been collected somewhere in Eastern Turkestan. It appears best to leave the type locality unfixed until the genus is revised.

2. *Thrinchus schrenkii* Fischer de Waldheim 1846.

1846. *Thrinchus schrenkii* Fischer de Waldheim, *Nouv. Mem. Soc. imp. Nat. Moscou* **8** : 259, pl. XXVII, fig. 1.

Notes. See under preceding species.

Type locality : Dzhungaria has been quoted by Fischer, but more precise indications are obtainable from the routes of Schrenk's travels (see above, p. 58).

3. *Thrinchus tuberculosus* Tarbinsky 1926.

1926. *Thrinchus tuberculosus* Tarbinsky, *Ann. Mag. nat. Hist.* (9) **17** : 88, figs. 1, 2.

Type locality. Southern Bokhara, Kabadian : Gilembov.

4. *Thrinchus variegatus* Tarbinsky 1926.

1926. *Thrinchus variegatus* Tarbinsky, *loc. cit.* : 89, fig. 3.

Type locality. Ferghana : Andizhan.

STRUMIGER Zubowsky 1896.

1896. *Strumiger* Zubowsky, *Horae Soc. ent. ross.* **30** : 188.
1927. *Strumiger* Uvarov, *Sarantcheviye Srednei Asii* : 111, 149.

Genotype : *Strumiger desertorum* Zubowsky 1896, the only original species.
Diagnosis. See Zubowsky (*loc. cit.*) and Uvarov (*loc. cit.*).

1a. *Strumiger desertorum desertorum* Zubowsky 1896.

1896. *Strumiger desertorum* Zubowsky, *Horae Soc. ent. ross.* **30** : 189.
1927. *Strumiger desertorum* Uvarov, *Sarantcheviye Srednei Asii* : 150, figs. 123, 173.

Note. Saussure's (1884, *Prodr. Oedip.* : 221) *Thrinchus schrenkii* var. *minor* from Askhabad in Turkmenistan was probably this insect, but the name is not valid, as no description has been given.

Type locality. Turkmenistan: Michailovskaya railway station on the Caspian Sea.

1b. *Strumiger desertorum persa* Uvarov 1933.

1933. *Strumiger desertorum persa* Uvarov, *Trav. Inst. Zool. Acad. Sci. URSS* **1** : 211.

Type locality. E. Iran, Khorasan province : Atkul, S.W. of lake Namaksar.

Incorrectly Included Species.

1. *Thrinchus accessorius* Fischer de Waldheim (1833, *Bull. Soc. imp. Nat. Moscou* **8** : 379; 1846, *Nouv. Mem. Soc. imp. Nat. Moscou* **8** : 262, pl. XI, figs. 4, 4b). Saussure (1884, *Prodr. Oedip.* : 229) for some reason regarded this species, described from Georgia, Caucasus, as a doubtful synonym (quoted with a question mark) of *Eremobia* (now *Asiotmethis*) *limbata* Charpentier 1842, which is restricted to southern Balkan peninsula. Kirby (1910, *Syn. Cat. Orth.* **3** : 287) accepted this synonymy and used Fischer's name as an earlier one for the Balkan insect. However, the two descriptions of *T. accessorius* by Fischer and its figures (Fischer 1846) show very clearly that it cannot be referred to any genus allied to *Tmethis* because of the pronotal carina being entire in the prozona. It may be a member of the subfamily Oedipodinae, but no insect even remotely similar to the description and the figures is known from the Caucasus, nor indeed from anywhere else. The name *Thrinchus accessorius* must, therefore, remain in abeyance until the type (if existent) is re-examined.

2. *Tmethis suschkini* Adelung 1907 has been recorded under this name by Kirby (1910, *Syn. Cat. Orth.* **3** : 289) owing to a slip, since it was originally described as a *Sphingonotus* and correctly entered as *S. suschkini* on p. 274 of Kirby's Catalogue.

Alphabetical Index of Names of the Thrinchini.

Specific and subspecific names are quoted with the names of the genera to which they are referred now, and not in the original, or the subsequent, combinations. Synonyms are in brackets.

accessorius F.W., *Thrinchus*, 70.
adaliae Uv., *Asiotmethis*, 56.
(*aegyptius* Uv., *Tmethis*), 46.
afghana Rme., *Eremocharis*, 51.
afghana Uv., *Eremopeza*, 43.
(*algerica* Sauss., *Tmethis*), 65.
angusta Uv., *Eremopeza*, 44.
appulum Costa, *Prionotropis*, 39.
asiaticus subsp. n., *Tmethis*, 66.
Asiotmethis, gen. n., 37, 52.
Atrichotmethis gen. n., 37, 51.
aurantipes Uv., *Eremopeza*, 42.
australis Tarb., *Asiotmethis*, 53.
azami Uv., *Prionotropis*, 40.
(*azurea* Nav., *Cuculligera*), 39.

bampura Uv., *Eremocharis*, 50.
barcaeus Salfi, *Tmethis*, 66.
beicki Rme., *Filchnerella*, 68.
bicoloripes Mor., *Eremopeza*, 43.
(*biloba* St., *Eremobia*), 55.
brachycera Kby., *Eremocharis*, 50.

campanulatus F.W., *Thrinchus*, 69.
(*capucina* Nav., *Cuculligera*), 39.
carinatus F., *Eremotmethis*, 46.
(*carinatus* Uv., *Tmethis*), 44.
cinerascens St., *Eremopeza*, 42.
cisti F., *Tmethis*, 63.
clavelii Luc., *Tmethis*, 65.
clavicornis Rme., *Eremocharis*, 49.
(*continuata* Serv., *Eremobia*), 46.
crassus Uv., *Pezotmethis*, 60.
(*cucullatus* F.W., *Thrinchus*), 54.
(*Cuculligera* Fisch.), 38.
cyanipennis Sauss., *Iranotmethis*, 45.

desertorum Zub., *Strumiger*, 70.
dimorphus Uv., *Asiotmethis*, 56.

(*elephas* Sauss., *Batrachotettix*), 47.
(*Eremobia* Serv.), 61.
Eremocharis Sauss., 36, 47.
Eremopeza, Sauss., 36, 41.
(*Eremoplana* Sauss.), 41.
Eremotmethis gen. n., 36, 46.
escherichi Kr., *Asiotmethis*, 56.

fasciatus F.W., *Asiotmethis*, 54.
ferghanensis Uv., *Pezotmethis*, 60.
festiva Sauss., *Eremopeza*, 44.
Filchnerella Karny, 37, 67.
flavolimbus Vor., *Asiotmethis*, 53.
flexuosa Serv., *Prionotropis*, 39.
fuscipennis Redt., *Melanotmethis*, 60.

(*gibber* Uv., *Tmethis*), 44.
gibbera St., *Eremopeza*, 43.
gigas Kby., *Eremopeza*, 44.
Glyphanus Fieb., 37, 58.
gracilis Sauss., *Tmethis*, 65.
(*grandis* Portsch., *Eremobia*), 44.
(*granulata* Jacobs, *Eremocharis*), 49.
granulosa Wlk., *Eremocharis*, 48.

Haplotropis Sauss., 21.
harterti Uv., *Tmethis*, 66.
heldreichi Br.W., *Asiotmethis*, 55.
heptapotamicus Zub., *Asiotmethis*, 54.
hirtus subsp. n., *Tmethis*, 67.
(*hispidulum* P.B., *Acrydium*), 63.
holtzi Wern., *Asiotmethis*, 56.
(*holtzi* Uv., *Tmethis*), 57.
(*hotsoni* Uv., *Tmethis*), 44.
hummeli Sjöst., *Rhinotmethis*, 68.
hystrix Germ., *Prionotropis*, 40.

(*incisa* Jann., *Prionotropis*), 39.
incristata Bol., *Tmethis*, 35, 67.
inermis Uv., *Asiotmethis*, 56.
insignis Luc., *Tuarega*, 47.
Iranotmethis gen. n., 36.

(*jaminii* Luc., *Eremobia*), 47.
jubatus Uv., *Asiotmethis*, 54.

karatavicus Uv., *Pezotmethis*, 60.
khorasana Uv., *Eremocharis*, 50.

laeviuscula Kr., *Tmethis*, 35.
lata Uv., *Eremopeza*, 43.
limbatus Charp., *Asiotmethis*, 55.
(*limbatus* F.W.), *Thrinchus*, 54.
lugubris H.S., *Asiotmethis*, 54.

maculinervis St., *Prionotropis*, 38.
maroccanus Bol., *Tmethis*, 67.
Melanotmethis gen. n., 37, 60.
(*minor* Sauss., *Thrincus*), 70.
montanus Uv., *Pezotmethis*, 59.
(*moritzi* Uv., *Tmethis*), 46.
mozabitica Kr., *Tmethis*, 65.
(*muricatus* F.W., *Thrinchus*), 54.
muricatus Pall., *Asiotmethis*, 53.

nigrescens Pyln., *Pezotmethis*, 60.

obtusus Fieb., *Glyphanus*, 59.
(*olivieri* Kby., *Tmethis*), 63.
ovipennis Uv., *Asiotmethis*, 56.

(*pallasii* Stoll, *Gryllus Locusta*), 53.
pamphagoides Karny, *Filchnerella*, 68.
perezii Bol., *Prionotropis*, 39.

persa Sauss., *Iranotmethis*, 45.
persa Uv., *Strumiger*, 70.
Pezotmethis gen. n., 37, 59.
Prionotropis Fieb., 36, 38.
pulchripennis Serv., *Tmethis*, 66.
pulchripes sp. n., *Asiotmethis*, 60.
pylnovi B.-B., *Pezotmethis*, 60.

reducta Uv., *Eremopeza*, 44.
Rhinotmethis Sjöst., 37, 68.
rhodanica Uv., *Prionotropis*, 40.
roseipes subsp. n., *Eremocharis*, 49.
rufipes subsp. n., *Eremocharis*, 50.

saussurei Uv., *Eremopeza*, 43.
schrenkii F.W., *Thrinchus*, 69.
semenovi Zub., *Atrichotmethis*, 52.
serricornis F.W., *Asiotmethis*, 57.
sontiaca Uv., *Prionotropis*, 40.
(*Staurotylus* Ad.), 21.
Strumiger Zub., 38, 70.
(*stummeri* Kuthy, *Eremobia*), 54.
subsulcata St., *Eremocharis*, 48.
sulphurans Bol., *Prionotropis*, 39.
(*suschkini* Ad., *Tmethis*), 70.
syriacus Bol., *Utubius*, 68.

tartarus Sauss., *Pezotmethis*, 59.
tauricus Tarb., *Asiotmethis*, 54.
Thrinchus F.W., 38, 69.
(*Thrincus* Sauss.), 69.
Tmethis Fieb., 37, 61.
transiens Uv., *Asiotmethis*, 58.
Tuarega gen. n., 36, 47.
tuberculosus Tarb., *Thrinchus*, 69.
tunensis Sauss., *Tmethis*, 65.
turritus F.W., *Asiotmethis*, 54.

unicolor Uv., *Melanotmethis*, 61.
urfensis Rme., *Prionotropis*, 39.
Utubius Uv., 37, 68.

variegatus Tarb., *Thrinchus*, 69.
(*versicolor* Stoll, *Gryllus Locusta*), 63.
violacea Uv., *Eremopeza*, 43.
virescens Uv., *Eremopeza*, 42.

wazira sp. n., *Eremocharis*, 51.

(*zacharjini* B.-B., *Tmethis*), 57.
zagrosi Uv., *Iranotmethis*, 45.
zahrae Uv., *Utubius*, 68.
zaitzevi Uv., *Atrichotmethis*, 52.

AN ORIENTAL MEALYBUG (*PSEUDOCOCCUS LILACINUS* CKLL.) (HEMIPTERA) AND ITS INSECT ENEMIES

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E.H.N

With Plates 1–4 and Seven Text-figures.

In 1936 and 1937 the writer travelled in a number of countries in the Orient with the object of studying the natural control of the Cacao mealybug, *Pseudococcus lilacinus* Ckll., and sending such insects as seemed desirable to Kenya Colony, East Africa, in the hope that one or more of them would become established and prove a useful factor in the control of the coffee mealybug, *Pseudococcus kenyae* Le Pelley. The present paper does not deal with any aspect of the East African work connected with this project, which may be dismissed here by stating that none of the primary parasites of *lilacinus* which were tried in Nairobi could be reared on *P. kenyae*, and it is not expected that any of the predacious insects, some of which were bred in Nairobi and released, will become established.

It seems, however, that an account of certain aspects of the work in the Orient should be recorded, as adding to our knowledge of a widespread species of mealybug. It is necessary to mention that such observations as it was possible to make were mostly incidental to the heavy work of preparing and sending numerous shipments of insects to Kenya, and time did not permit the conclusion of work on the biology of the various parasites. In order to do that it would have been necessary to prolong the journey with work not contributing directly to the practical objects of the expedition, and time would not permit. The identification of all the material is not complete, but it has been thought advisable to mention briefly a number of unidentified insects under a temporary designation in order to indicate the type of complex that exists in the different areas. In view of the possibility of other biological control work involving this mealybug, this may be of value to future workers. It is hoped to publish a short list of further identifications at a later date.

The journey was made possible through a grant from the Colonial Development Fund. A list of those who assisted me would occupy pages, and no attempt to give complete acknowledgements will be made here. However, for advice and facilities directly contributing to work actually described in this paper, I wish to offer my grateful acknowledgements to Dr. L. B. Uichanco, Dr. J. van der Vecht, Dr. J. G. Betrem, Mr. R. E. Holttum, Mr. N. C. E. Miller, Dr. J. C. Haigh and Mr. M. C. Cherian; also to Sir Guy Marshall, F.R.S.

For the taking of four of the photographs I am indebted to the School of Forestry, Los Baños; for the taking of two of them and the preparation of all the prints used, I am indebted to a colleague, Mr. C. F. Fox.

Recognition.

This insect was first described as *Pseudococcus lilacinus* by Cockerell (1905),[1] and later in the same paper he also described *tayabanus* as another

[1] See Bibliography (p. 92.)

species. Morrison (1920) studied material which was labelled by Cockerell " part of type " of *lilacinus* and *tayabanus* respectively, and concluded, as a result of extended study of mounted material, that the two lots were of the same species, and the name *tayabanus* therefore sank as a synonym because *lilacinus* had page priority. In the same paper, as a result of examination of type material received from Green of *Dactylopius crotonis* Green (1905, 1911), he placed this species also in the synonymy. This synonymy was accepted by Green (1922), and has been accepted generally by coccidologists. However, Betrem (1937) gave reasons why he considered *tayabanus* to be the valid name for this insect. He stated that the original description of Cockerell gives enough details for a certain identification, and that there is no doubt that the insect Cockerell described as *P. lilacinus* was in fact *P. citri* (Risso). This he bases on the fact that *P. lilacinus* was described from *Citrus* which is the usual host of *P. citri*, while *P. tayabanus* was described from *Cacao*, a common host of the species under discussion; and, it seems, also on data concerning ratios of lengths of tibiae and tarsi. He stated: " Morrison (1920) studied material received from Cockerell as the type of above-named species. He found that the material consisted of only one species. Although he suspected that it was not the real type material, he synonymized both species."

It is of importance to decide the correct name for this well-known insect, and a discussion of Betrem's reasons for rejecting the name *Pseudococcus lilacinus* Cockerell is required. His statement that Cockerell's original description gives enough data for a certain identification, and that *P. lilacinus* is a synonym of *P. citri* cannot be accepted. On the contrary, Cockerell's description of *P. lilacinus* gives enough data to separate it conclusively from *P. citri*. There is (1) the shape, " globose," which *citri* is not, (2) the shape of legs " fairly short," while those of *citri* are relatively long, (3) the lilac colour on boiling in caustic potash, which is not exhibited by *citri* (using fresh material of *P. lilacinus* I confirmed this characteristic reaction in Los Baños in 1936), (4) " larva in body of female " in *lilacinus*, while in *citri* eggs are laid which require days to hatch.[2] (In point of fact, though it has been assumed from a study of mounted material that *lilacinus* is viviparous, I found in Los Baños that it is oviparous. The eggs hatched almost as soon as laid, nearly always in less than one hour.)

The food-plant argument of Betrem is of no significance because *P. lilacinus* has been taken on citrus on more than one occasion, and the dimensional data cited are inadequate to settle questions of specific identity. It is concluded therefore that *lilacinus* is the valid name for this species, as was shown by Morrison (1920). It may be remarked here that Betrem's statement that Morrison " suspected " that he had not examined real type material is incorrect. Morrison's statement is unequivocal on this point, he synonymised the insects on the basis of material received from and labelled by Cockerell, and suggested only as a possibility that he might have received two lots of the same species with different names attached. No evidence has been obtained to confirm this unlikely hypothesis. In the same paper Morrison gave it as his opinion that this insect, on account of its wide distribution and wide range of host-plants, would ultimately be found to be some previously described species from another part of the world. In view of the time that has elapsed since, and the widespread collecting of mealybugs during that time, this now appears very unlikely.

[2] Quayle (1938) says: " Under summer temperatures in southern California they hatch in from 6 to 14 days."

Pseudococcus kenyae previously referred to as *Pseudococcus lilacinus.*

There is one other complication in connection with the literature on *Pseudococcus lilacinus*, which arises from the fact that *P. lilacinus* has been mentioned many times (see Kirkpatrick (1927) *et al.*) as the species occurring in East Africa, and responsible in Kenya for very severe damage to *Arabica* coffee, in fact constituting one of the outstanding mealybug plagues of the world. This has since been shown to be due to misidentification, and the East African species was described for the first time by Le Pelley (1935). At first it was thought that the East African insect *Pseudococcus kenyae* was very similar to *P. lilacinus*,[3] but observations since that date have shown that the insects differ in many characteristics more striking than the morphological differences demonstrated in the original description, and these are published here for the first time. They are :—

(1) *Distribution.* The distribution of these insects does not overlap in any place. *P. lilacinus* is solely Oriental (except for slight penetration of the Australian region, the extent of which has not been accurately determined). *P. kenyae* is solely Ethiopian. This alone would not differentiate the insects because it might either constitute the natural range of a single species, or the insect in Africa might be an introduction from the Orient. *Pseudococcus kenyae* is known to be an introduction into Kenya,[4] and as James (1932) stated : " the evidence which can be adduced to show that the pest is a comparatively recent introduction is quite conclusive." This was accepted at the time, and has been further demonstrated since through its increasing spread into regions previously not attacked, and through confirmation of the fact that in Kenya it had no important hymenopterous parasites. Because it was known to be introduced, and because it was considered to be *P. lilacinus*, it was only a step to assume that it was introduced from the Orient, into Kenya, Uganda and Tanganyika. Later observations, however, by Melville in Uganda (unpublished) have shown that in that country it has all the characteristics of an indigenous insect, and supports a large complex of primary and secondary parasites which are instrumental in maintaining it at a low population density, in striking contrast to the severe attacks experienced in Kenya since 1923, the date when it was first found in that country.

If it were assumed to be one species only, it would be necessary to consider it indigenous in the Orient and in Uganda, but not in Kenya, which would be a very peculiar case of discontinuous distribution. Further, if it were one species indigenous in Uganda and the Orient, it might be expected that some species of hymenopterous parasites would be represented in both areas, but this is not so.

(2) *Altitude range.* The insects do not overlap in their altitude range. *P. lilacinus*, as has been stated, is a tropical insect with a maximum altitude

[3] In this connection Cockerell (1937) has stated : " Le Pelley (1935) made minute comparisons of specimens [of the coffee mealybug] found about Nairobi with the oriental insect and detected small differences which led him to describe a new species, *P. kenyae*. . . . I am convinced that he is right, although the characters relied upon are such as we should formerly have considered quite unimportant. It now remains to ascertain whether all the African supposed *P. lilacinus* is really *P. kenyae*, or whether (as seems most likely) both species occur. At all events, these studies have again opened up a new line of investigation, into the minute characters of species which behave differently and are biologically different entities, but which have eluded the taxonomist."

[4] Its specific name therefore was not appropriate; but *kenyae* may be understood to indicate " of Kenya " in the sense " of Kenya notoriety."

limit of approximately 3000 ft., and cannot reproduce in the highland conditions normal to *P. kenyae*.

(3) The insects in life are readily separable by naked eye. *P. lilacinus* "globose" as stated by Cockerell (1905), *P. kenyae* not so; and with marked differences also in the secretionary covering. These are shown clearly in pl. 1, figs. 1 and 2.

(4) Not one of the many species of primary parasites of *P. lilacinus* discovered by the writer in the Orient and sent to Kenya could be reared on *P. kenyae*, and the observations of Melville, who did the work at the receiving end, showed that nearly all the parasites took no interest whatsoever in the Kenya mealybug, nor would they oviposit in it.

(5) As stated by Cockerell, the pigment in the body of *P. lilacinus* is lilac after boiling in caustic potash. *P. kenyae* does not show this characteristic reaction.

(6) A further interesting difference can be recorded from comparisons of the symbionts in the mycetomes of both species, which Dr. Walter Carter of Honolulu was kind enough to make at my request. He reported (*in litt.*) as follows: "The symbionts from *P. kenyae* are all typical and consistent in the slides examined and entirely different from those of *P. lilacinus* taken in the Philippines."

The conclusions on these questions of synonymy may be summarised here, under the following three names:—

(1) *Pseudococcus citri* (Risso, 1813). Present in all the main zoogeographical regions. Indigenous range, not known, probably in Africa.

(2) *Pseudococcus kenyae* Le Pelley, 1935 (synonym *Pseudococcus kenyaensis* Betrem).[5] Ethiopian region. Limited at present to parts of Uganda and a small lake shore area in Tanganyika, and to part of Kenya. Indigenous range, part of Uganda and lake shore area in Tanganyika. Introduced into Kenya.

(3) *Pseudococcus lilacinus* Cockerell, 1905 (synonyms *Pseudococcus tayabanus* Cockerell and *Dactylopius crotonis* Green). Oriental region from Formosa to western coasts of India, with slight penetration into Islands of Australian region. Indigenous range, Oriental region, probably Java.

Distribution.

Geographical range.

Pseudococcus lilacinus is found in Formosa, the Philippine Islands, Dutch East Indies, Malaya, Ceylon and South India. I collected it in all these localities except Formosa, which I did not visit. It was found on Lombok, and at Macassar in Celebes, east of the zoogeographical line of Wallace; how far east it exists is not known, but it has not, so far as I know, been definitely recorded from Australia or New Guinea, though in correspondence, Mr. J. L. Froggatt of New Guinea informed me that a *Pseudococcus* belonging to the same group is present, and this may prove to be *lilacinus*. The western coasts of southern India are the limit of its authentic range in that direction, and, as has been stated, the numerous references to *P. lilacinus* from Kenya,

[5] This insect is referred to by this name by Betrem (1936) on p. 129 (where the date 1926 obviously should be 1936) and on p. 152. It is again referred to as a synonym of *P. kenyae* by Betrem (1937) on p. 62 (where the spelling given is *P. kenyaensia*). But in the literature available to me I cannot find that it was formally described by Betrem.

Uganda and Tanganyika refer to a different species. There is one record of *P. crotonis* from Zanzibar (Green 1916) but it was recorded that the insects were not quite typical, and it is not known to what species this refers; it is possible that it may have been an importation of *P. lilacinus* from the Orient, but it seems more likely that it was some other insect. Another reference to *P. lilacinus* from Nyasaland (Smee 1930), of which it was stated " this determination requires authoritative confirmation," proved on examination of specimens to refer to a different species, neither *P. lilacinus* nor *P. kenyae*. One other reference to *P. lilacinus* from Palestine by Carmin and Scheinkin requires confirmation; it will probably prove to refer to a different species.

In the Philippine Islands, Dutch East Indies, Ceylon and parts of South India it is common, but in Malaya it is rare. Prior to my visit it had been recorded only once, from Johore State on Citrus (Miller 1932), and the Entomological Section of the Department of Agriculture, where I was privileged to consult the detailed records of insect distribution, had no other record. I searched intensively in Singapore Island, and parts of Negri Sembilan and Selangor without finding the insect. The only place at which it was collected in Malaya was on Penang Island, where a fairly heavy attack was present on a few guava trees. It is remarkable that it is not present more widely in Malaya, and particularly that it could not be found, and has not been recorded, in Singapore Island, which is well within its normal range and grows quantities of its chief hosts such as *Annona muricata*; particularly as large quantities of fruit, including that of *Annona muricata*, are imported from Java to Singapore, where I am informed that there are no quarantine restrictions on its entry. No explanation of this is offered.

Altitude range.

It will be noticed that the range of this mealybug is entirely within the tropics, and the fact that it is a truly tropical insect is shown by its altitude limit, which is approximately that of the coconut: about 3000 ft. in most of the places visited. In the following table are shown the approximate maximum heights at which I collected, and the greatest height at which *P. lilacinus* was taken. The last record in the table I owe to the kindness of Dr. J. G. Betrem; this is a case of *P. lilacinus* from coffee on an estate, on the Idjem Plateau, which lies between 2600 and 3600 ft., though the part of the estate concerned was not recorded.

TABLE.

Place	Maximum height of search. Ft.	Highest place at which *P. lilacinus* found. Ft. (approximate)		Authority
Java	4600	Tjiliwoeng	2600	Le Pelley
Bali	5400	Near Sekargoela	1700	,,
Penang . . .	2300	Near sea-level		,,
Ceylon . . .	7000	Road from Kandy to Nuwara Eilia	3100	,,
S. India . . .	8000	Burliar	2800	,,
Java, Idjem Plateau .		Somewhere over	2600	J. G. Betrem

The fact that in many places visited there was a constant succession of some of its favourite host-plants from sea-level to well above the maximum limit at which it was found, indicates that it is dependent on tropical conditions

and cannot exist where these do not occur. It was found that no development occurred in Nairobi at laboratory temperatures though insects were bred by incubating them at 28° C.

Host-plants.

Pseudococcus lilacinus has a large range of host-plants, lists having been given by Green (1922), van der Goot (1917), Whitney (1923), Dammerman (1929), Takahashi (1929), Ramachandran and Ramakrishna Ayyar (1934) and others. My own observations include many of the host-plants mentioned by the above writers, but only those species which I believe represent new records are given here :—

Philippines, 1936–1937. *Aphania loheri, Antidesma bunius, Bauhinia monandra, Bridelia stipularis, Carissa arduina, Erythrina variegata, Ficus ulmifolia, Lagerstroemia speciosa, Mucuna nigricans, Ptechosperma macarthurii, Schizolobium excelsum, Spondias lutea, Derris* sp.

S. India, 1937. *Sesbania grandiflora, Gliricidia maculata, Trewia nodiflora.*

From a study of the complete records of host-plants a few points of interest emerge. *Citrus* is recorded as a host by several of the above writers (see also Ref. 2, 3) but it is generally considered to be an infrequent host and this was confirmed by my extensive and intensive collecting, as the insect was only once obtained from *Citrus*. *Coffea arabica* is seldom mentioned as a host-plant (though Takahashi records it); the plant usually grows above what has been shown to be the upper altitude limit for the insect. Certain plants crop up again and again in the records and must be considered the chief hosts. These include *Annona muricata, Psidium guajava, Theobroma cacao, Ceiba pentandra* and species of *Bauhinia, Spondias*, and *Erythrina*. My collecting in the Philippines was chiefly on *Psidium guajava, Bauhinia monandra, Annona muricata*, and *Spondias lutea*; in the Dutch East Indies on *Ceiba pentandra, P. guajava, A. muricata*, and *Theobroma cacao*. In Ceylon on *T. cacao*, and *A. muricata*; and in South India on *Gliricidia maculata, Ailanthus excelsa*, and *A. muricata*.

The insect is not generally considered a serious pest, and Dammerman (1929) has stated that " in Java it must even be reckoned among the useful insects, as it attracts the black cocoa ant (*Dolichoderus*) which in turn is used against *Helopeltis*." The direct damage it does to the crop plants attacked is limited, because, due to its insect enemies, it seldom if ever becomes sufficiently numerous on them to affect their growth. But there remains the possibility of its introduction and establishment in tropical countries outside its present range, following which, it might become a serious pest. There are numerous records of its interception in quarantine in Hawaii and also in California and other states (see numbered references 1–9, and Whitney (1923)). It is unlikely that it would become established in the United States (though it might possibly just hang on in the southern part of Florida), but there would seem no good reason why it should not establish itself in the Hawaiian Islands. In point of fact this may be considered rather as a testimony to the efficacy of the Hawaiian Plant Quarantine Service. If it should become established there it might well prove a serious pest, because the general oriental view that a fruit need not necessarily be any the worse for being covered with bugs [6] would not be accepted in the markets of Hawaii.

[6] Soursop fruits (*Annona muricata*) in the markets of Java are frequently heavily infested with mealybugs. In some places the quickest way of collecting *lilacinus* was to buy such fruits in the markets. The quality of the fruit is apparently unaffected.

It seems not only possible but likely that this insect will eventually be introduced into tropical countries outside its present range,[7] and if it should, it may well become a serious pest. The observations herein recorded will be available to enable a rapid application of control by the introduction of such insect enemies as seem most likely to be of value in the conditions prevailing.

In respect of host-plants one interesting fact emerges from the interception records, which is that Orchids are recorded over and over again (Ref. 1, 4–9), seven species of Orchids being recorded in one list (Ref. 4). This does not indicate that these plants are favourite hosts, so much as the frequency with which they are sent from the Philippines by way of trade. But the presence of the insect on so many orchids, and the world-wide trade in these plants, increases the likelihood that this insect will extend its range by accidental introduction.

Ants Attending the Mealybug.

So long ago as 1915 detailed observations on the relationship between this mealybug and two species of ants *Dolichoderus bituberculatus* Mayr and *Plagiolepis longipes* Jerd. were made by van der Goot (1916) (1917) in Java. In addition there are records by Takahashi (1929) of *Camponotus rogenhoferi* attending *P. lilacinus* in Formosa, and by Krishna Ayyar (1935) of *Camponotus compressus* Latreille attending it in South India.

A few incidental observations on ants attending this mealybug were made during the course of the journey. At Los Baños a number of different ants were associated with it. The most striking of these was *Oecophylla smaragdina* (F.) (see pl. 2, fig. 3) which would often fiercely attack anything disturbing the mealybug; for example, it would repeatedly bite the needle with which bugs were being removed. *P. lilacinus* is often to be found on trees bearing the large leaf nests of this ant, which was observed webbing the leaves with larvae held in its jaws as has been described a number of times. It is not thought that the population of mealybugs is markedly affected by its association with this species of ant, particularly as the ant did not seem to disturb either coccinellid larvae or parasites.

Plagiolepis longipes is another species which often attends the mealybug in the Philippines. Among the other ants observed to attend this insect in Los Baños were *Tapinoma megacephalum* F., *Hypoclinea affinis* Emery, and a species of *Camponotus* thought to be *pubescens* Mayr or a subspecies. Ants attending the insect often remove the wax almost completely from certain areas of the body; this was noticed particularly in the Philippines, where insects so denuded are sometimes the rule rather than the exception. This is shown clearly in pl. 3, fig. 4. The photograph also shows two mummified mealybugs of the same species, parasitised by *Pseudaphycus orientalis*, from which the wax has not been removed in this manner.

Few observations on the ants attending this mealybug were made in Java, but *Hypoclinea affinis* commonly attended it, and was observed both at Malang and Buitenzorg.

In Ceylon *Oecophylla smaragdina* was again in evidence, and two other ants were of importance, namely *Paratrechina longicornis* Latreille and *Technomyrmex detorquens* Walker; the latter commonly attended the mealybug on *Theobroma cacao* at Peradeniya.

[7] In this connection it is of interest to note the statement of Uichanco (1935) that this mealybug is remarkably tolerant to dry conditions; he concluded as a result of observations that the insect could exist on yam of less than 16 per cent. moisture content.

Biological Control Factors.

(*A*) *Philippine Islands.*

The observations in the Philippines were made at Los Baños, Laguna, Luzon, about 60 miles from Manila, mostly in the grounds of the School of Forestry or the Agricultural College, though the collections of mealybugs were often made at a distance of several miles from this centre. The insect is common in Los Baños, but during the time it was observed, from August 1936 to February 1937, it was only present in great numbers very locally on one or two trees at different times. A fairly severe attack which persisted for several months existed on a few guava trees in a sheltered position, and very severe attacks were noticed on a few young *Bauhinia* trees (see pl. 3, fig. 5). With these exceptions, the large collections of material required for the work entailed considerable searching, sometimes occupying the full time of three collectors. The insect enemies found were four species of coccinellid, two species of cecidomyiid, one lycaenid, and a number of endoparasitic chalcids, of which certain species were shown to be primary while several others were suspected of being secondary parasites. There are apparently no previous published records of enemies of this mealybug in the Philippines.

Lycaenidae.

The Lycaenid *Spalgis epius* Westwood apppears to be of considerable importance as a predator, because, although not present in Los Baños in great numbers, it is exceedingly voracious. In all the observations made no parasites of the larval or pupal stages of this butterfly were found. Smith (1914) records the species *Spalgis substrigata* as a valuable predator of mealybugs in Manila.

Coccinellidae.

The coccinellids, with one exception, did not appear to be of real importance as factors in the natural control of the mealybug, as they were nowhere present in large numbers. The exception was *Platynaspis stictica philippensis* Kor. which was always present with collections of the mealybug from guava, sometimes in large numbers. The larva is oval with flat ventral and convex dorsal surface. The dorsal surface is dull yellow with a light powdery dusting, ventral surface and legs bright light yellow. The larva appears to be almost entirely free from molestation by ants. The larvae were hardy in captivity at Los Baños and the adult lived at least up to a month in the laboratory. No parasites of any stage of this coccinellid were observed.

Another coccinellid observed to prey on *lilacinus* was *Aspidimerus tristis* Wse. This was taken at Los Baños on young plants of *Tectona grandis* but was not common at any time. The larvae and pupae are completely white with about six rows of thick white waxy filaments. Parasites of this insect were not found. The species *Aspidimerus orbiculus* was recorded by Smith (1914) as very important on certain mealybugs.

A species of *Scymnus* was also found to prey on *lilacinus* on guava; it was uncommon.

Another coccinellid *Nephus* sp., possibly *oblongosignatus* Mulsant, was observed. This insect was usually rare but in one collection of *lilacinus* from guava it was common and may be of importance at certain times. The larva is white with many thin waxy filaments up to 3 mm. long covering it entirely. It was observed to be parasitised by a species of *Homalotylus*.

CECIDOMYIDAE.

The cecidomyids were *Coccodiplosis pseudococci* de Meij., and an unidentified species. The former is perhaps the more common, though the other is also present in large numbers in the larval stage. The larvae of the unidentified species have the ability to jump considerable distances, they do not pupate on the plant; it was found difficult to rear the insect in the laboratory, and very few adults were obtained. Smith (1914), who records two species of cecidomyids predacious on mealybugs in Manila, states that the one with jumping larvae pupates in the soil. The few adults I obtained were from larvae which were given soil in the laboratory, but the great majority of larvae died without pupating, and they were not found in the pupal stage in the field. The larva of *Coccodiplosis pseudococci* does not jump and it pupates on the plant, either under the mealybugs, or in proximity to the insects on which it has fed. The time in the pupal stage was found to be eight days. It forms a silken cocoon, and the large numbers of these larvae that can be present is shown by the almost complete mat of silk remaining on the fruit or other part of the plant after the mealybug infestation has been cleaned up. The insect must be considered as a mealybug enemy of distinct importance. Larvae have been observed to feed on the adult mealybugs; necrotic lesions are often present on the undersides of insects under which they live, and as many as six midge larvae have been found under one mealybug. A mealybug lives for a considerable time even though several midge larvae are present, but cases occur where it appears that the mealybug has been killed.

Coccodiplosis pseudococci is parasitised at Los Baños, in the pupal stage, by a species of *Calliceras*. A collection of mealybugs on guava made in January 1937 at Los Baños was examined to obtain some data on the numbers of midges present. The figures recorded were as follows:—the number of adult mealybugs all definitely settled down on the plant was 176; there were 108 midge larvae or pupae present and 17 midge cocoons obviously containing parasites. Doubtless other of the midge pupae were also parasitised but the cocoons in this case were not broken open for examination.

A detailed examination of the contents of 47 midge cocoons was made on 6th September, 1936, each cocoon being opened with needles. There were present the following living insects:—1 midge pupa; 4 midge adults (not yet broken out of cocoon); 6 parasite larvae; 63 parasite pupae; and 25 parasite adults (not yet broken out of cocoon) and with the material there were 37 midge larvae not yet pupated. In one case there were 5 parasite pupae in one midge cocoon; this was the highest observed, but four or three parasites in one cocoon was not uncommon. The total number of all stages of midges in this material was 42 and the total number of all stages of parasites was 94. This probably represents an advanced stage in the progress of the infestation, but it proves that the insect can be very heavily parasitised, which no doubt seriously affects its ability as an enemy of *P. lilacinus*.

The life-history of the *Calliceras* was not followed in detail. It was observed, however, that they would not take any interest in naked midge larvae, but would oviposit immediately a cocoon was made, before the midge larva had pupated inside it. The parasite larvae are ectoparasitic on either midge larvae or pupae. On the two occasions which were accurately timed, the development of the parasite from oviposition to emergence of the adult occupied 12 days, and the parasite passes through its life-history very much more quickly than the midge.

Encyrtidae.

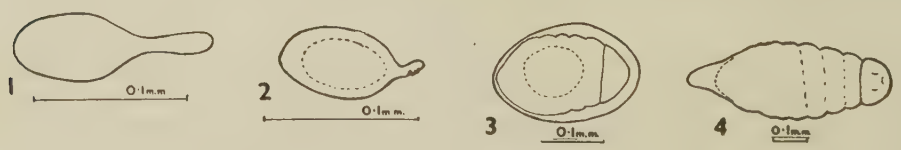
Of the endoparasitic hymenoptera three species were of most importance; most of the seven or eight other species found were comparatively rare and the status of most of them was not definitely determined though some appeared to be primary while others were almost undoubtedly secondary.

1. *Pseudaphycus orientalis* Ferr.

The most important of the primary parasites was, when discovered, an undescribed species of the genus *Pseudaphycus*, which was later described by Ferrière (1937). It is a minute insect which attacks large mealybugs and a number of parasites may develop in a single mealybug. The first eleven mealybugs parasitised by this species, that were collected in the field, produced a total of more than 185 parasites, and in each of two cases more than thirty parasites emerged from a single mealybug.[8] Further counts of the parasites produced from single mummies showed 587 parasites from 49 mealybugs, an average of 12; and 227 parasites from 29 mealybugs, an average of 8.

At first it appeared open to question whether this insect was polyembryonic, but this seems not to be the case. Five parasites have been observed ovipositing in one mealybug at the same time and eleven eggs have been dissected from one mealybug directly after oviposition; three days after oviposition 26 eggs with larvae completely formed inside were dissected from one mealybug; four days after oviposition 17 larvae were dissected from one mealybug. The parasite is very active in oviposition, quickly finding suitable mealybugs and almost immediately turning and inserting the ovipositor. The following notes were made at the microscope: "Slight exploration with antennae lasting about five seconds, parasite backs and bends up ends of wings, thrusts ovipositor out and hits mealybug low down on the ventral surface, complete insertion of ovipositor takes about 10 seconds. The egg is forced out by muscular movements which give the appearance that the abdomen is 'pumping.' The parasite usually moves away in 20 or 30 seconds but may stay a minute or more, wings either come back by themselves or are pushed back with posterior legs. Mealybug usually moves on being stung, but parasite continues and is not readily disturbed."

The ovarian egg is shaped something like a ninepin or bowling pin (fig. 1). Three to four hours after deposition its stalk shrinks to less than half its size



Figs. 1–4.—Eggs and larva of *Pseudaphycus orientalis* Ferr.

though there is little or no increase in size of the egg at this time (fig. 2). Three to four days after deposition the egg hatches; it is shown just before

[8] In each of these cases one or more parasites escaped from the tube while being transferred to other tubes for breeding. The species is not markedly phototropic and the first attempts to handle them were made with mouth-suction tubes, which were not entirely satisfactory and resulted in the loss of a few insects; later a satisfactory shaking and jarring technique by knocking the ends of the tubes was employed, which proved satisfactory and quick. Almost all the work with this species was done in glass tubes. Gelatine capsules could not be used owing to the high humidity at Los Baños.

hatching in fig. 3. The larva four days after hatching is shown in fig. 4. The insects pupate each in a separate " cell " inside the mealybug mummy, and emerge usually from a number of holes, but not necessarily, or even usually, are as many holes made as there are parasites present.

The length of life from deposition of egg to emergence of adult was recorded in a large number of insects reared in the laboratory. In the fairly uniform conditions of temperature during September and October this occupied from 19 to 21 days, and in the majority of cases 20 days, with great regularity. There was a decided drop in temperature in November, and from egg to adult occupied 23 or 24 days.

		Days; egg to adult	Temperature		
			Mean Max.	Mean Min.	Mean
September	10–28	19	81·0	69·8	75·8
October	1–20	20	79·5	70·0	75·0
November	8–30	23	76·6	69·0	73·5

The progress of this parasite under natural conditions was observed. A very heavy attack of *P. lilacinus* on small trees of *Bauhinia monandra* at Los Baños was seen, in early December 1936, to be heavily attacked by this parasite. A few inches of stem from this infestation were cut on December 12th, and the numbers of insects recorded in the following categories :—

1. Adult *lilacinus* not obviously parasitised 150
2. *P. lilacinus* mummies from which *Pseudaphycus* had emerged 23
3. *P. lilacinus* mummies containing *Pseudaphycus* . . . 49
4. *P. lilacinus* mummies containing other parasites . . 2

From the 49 mummies, 587 *Pseudaphycus* emerged.
A collection from the same tree made on January 14th showed :—

1. Adult *lilacinus* not obviously parasitised 2
2. *P. lilacinus* mummies from which *Pseudaphycus* had emerged 119
3. *P. lilacinus* mummies containing *Pseudaphycus* . . . 38
4. *P. lilacinus* mummies containing other parasites . . 17

Shortly afterwards the mealybug was completely cleaned up. This amazing efficiency is thought likely to result in rather large fluctuations in the mealybug population, because it so completely wipes out the mealybug that the parasite cannot maintain itself, and colonies of the mealybug appear to start up and proceed towards a heavy infestation before the parasite finds them. Only one complete wipe out, that described above, was observed during the time I was in Los Baños, but evidence of the clearing up of a previously exceptionally heavy attack of the mealybug by this parasite was present when I first arrived in August, tending to bear out the above opinion. *Pseudaphycus orientalis* was not everywhere present in such numbers, however, and was absent from some collections; it was only found in great numbers on *Bauhinia* during the time covered by this work.

As is not uncommon in this genus the females are more numerous than the males, probably in about the ratio of three females to one male, though exact figures are not available at the time of writing. The insects normally copulate

immediately on emergence and this is so quickly accomplished that despite the smaller proportion of males, it must be uncommon for a female to remain unfertilised in the field. Immediately the female emerges, the male momentarily makes contact with the antennae, head to head, then moves quickly to the rear, mounts on the female's back, head directed forwards, jabs with the aedeagus, makes firm contact immediately, stays (in cases observed) not more than one second, then turns quickly so that the insects are facing in opposite directions, and pulls hard for release. The female bends the tip of the wings over the back during copulation, as it does during oviposition. The whole process of copulation from the original contact took, in cases observed, not more than three seconds. After fertilisation the female will apparently not receive the male again, as in hundreds of insects watched copulation was never seen except immediately after emergence, though the males sometimes approached females and apparently attempted copulation at other times. The females are ready for oviposition immediately after emergence; dissection shows the eggs to be mature at this age, and in the successful rearing work with this insect, females of the same day's emergence were used for oviposition. Parasites live approximately 16 days in the laboratory when fed with honey.

There seems little doubt that hyperparasites of such a common primary will be found, but none of any importance appeared during the course of this work. Two species (C and E), however, emerged at different times from mummies which also produced *Pseudaphycus*, and these were probably secondaries.

2. *Aphycus* sp.

This insect, which has been identified by H. Compere as a new species of *Aphycus*, was not a common parasite. In cases observed it attacked small mealybugs, and only one parasite developed in each.

3. *Anagyrus lilacini* Ferr.

Another primary parasite of importance is *Anagyrus lilacini*, which was described by Ferrière (1937). This was an undescribed species when first obtained. It attacks fully grown mealybugs, and normal sized specimens emerged from large " mummies," one parasite only developing in one mealybug. The insect readily oviposits in *lilacinus*; the parasite turns, and usually after a number of attempts, it inserts the ovipositor. Often a small mealybug is stabbed, and the parasite may then have great difficulty in removing this mealybug from its ovipositor. The egg, one day after oviposition, is oval, and shows the remains of a stalk. The larva at first has a well-marked head and long tail; eight days after oviposition it still has both. The time from oviposition to emergence of the adult in the laboratory at Los Baños in September and October was approximately 22 days, varying from 20 to 24 days. The mean temperatures for these two months were almost identical (September Mean max. 80·5, Mean min. 69·8, October Mean max. 80·0, Mean min. 70·1); no records are available of the length of life in November, when the temperatures were lower.

The adult insect lived up to 30 days in the laboratory when fed with honey. The parasite was present in nearly all collections of mealybugs from different host-plants. At no time was it present in any big proportion of the insects, but it appeared to be a useful parasite, killing a certain number of mealybugs even when *Pseudaphycus* was dominant.

4. *Anagyrus* sp.

This insect is a small light-coloured *Anagyrus* apparently identical with the insect (species P) which is of chief importance as a parasite of *P. lilacinus* at Malang in Java. Only a few specimens were found in the Philippines.

5. *Taftia saissetiae* Gahan.

This insect, identified by H. Compere, was very common, emerging singly from large mummies of *P. lilacinus*. The genus was erected by Ashmead (1904) for the single species *T. prodeniae*, from specimens stated to have been bred at Manila from *Prodenia* sp. *T. saissetiae* was described by Gahan (1920), the type locality being Los Baños, and the host given as *Saissetia hemisphaerica* Targ. There is apparently no further information on their biology. It is thought that this insect will eventually prove to be a primary parasite but this has not been demonstrated. The insect lived only a few days in the laboratory and all efforts to rear it failed. The insects had the habit of standing head to head rubbing antennae, sometimes for days at a time; either two individuals would do this, or a whole group of ten or twelve. Copulation was not observed during many hours of watching, nor any successful case of oviposition. In this connection it may be mentioned that a species of *Tropidiophryne* in Nairobi has a similar habit of rubbing antennae, and this is usually followed after a variable interval, up to ten or fifteen minutes, by copulation; the habit in this species apparently being confined to single pairs. There seems little doubt that the habit of the Philippine insects is a modification of usual behaviour preliminary to copulation, the conditions provided in the laboratory having possibly been unfavourable for its completion.

Several hundreds of the insects were obtained from *lilacinus* mummies on a number of host-plants, and sometimes a large percentage of the mealybugs in a group were attacked. Pl. 4, fig. 6 shows a number of *P. lilacinus* mummified by this parasite. If this species should prove to be a primary parasite, as seems likely, it will be correct to consider it as a factor of real importance in the control of *lilacinus*.

(6) (7) (8) Other species (status unknown).

Three other parasites were obtained from mummies of *P. lilacinus*, two specimens of one (species D) from two mummies from *Bauhinia*, nine specimens of another (species G), three from each of three mummies from *Bauhinia*, two specimens of another (species N) from two mummies from guava.

(9) (10) (11) Other species (probably hyperparasites).

Three other parasites were obtained from mummies of *P. lilacinus*, all of which are thought to be hyperparasites. One of these is a species of *Achrysopophagus*, eleven specimens being obtained from two mummies of *P. lilacinus* on *Bauhinia*, eight specimens from one mummy and three from the other. Two species of this genus, *Achrysopophagus io* Girault and *Achrysopophagus rex* Girault, were described from Manila, said to be reared from *Pseudococcus citri* on bamboo (Girault 1920). These two species are also recorded by de Fluiter (1941) as having been " bred from mealybug-infected coffee berry clusters," and considered to be hyperparasites. One specimen of another insect (species J) emerged from a *lilacinus* mummy; it would not attack unparasitised mealybugs, but readily inserted its ovipositor in mummies. One specimen of another (species H) emerged from a mummy from *Bauhinia*; this insect took

no notice of unparasitised mealybugs but attempted to oviposit in a mummy of *P. lilacinus*.

In the cases of all the rarer parasites the mummy skin of the mealybug remaining after the emergence of the parasites was mounted to check the identity of the mealybug (*P. lilacinus*).

(*B*) *Netherlands East Indies.*

The mealybug *P. lilacinus* is common and widely spread here, and during my journey was collected in the following localities, in Celebes near Macassar, in Lombok, Bali, and in Java at Surabaya, Malang, Djember, Semarang, Batavia and Buitenzorg. Its bionomics have been dealt with at considerable length by van der Goot (1917). In Java the insect was so common on *Annona muricata* (especially on the fruit) and on *Ceiba pentandra* that no very widespread collecting was necessary. The complex of enemies in Java is on the whole similar to that in the Philippines, though there are noticeable differences. van der Goot (1917) records *Spalgis epius*, *Scymnus* sp., *Diplosis* sp. (apparently *Coccodiplosis pseudococci* de Meij.) and a chalcid (probably a species of *Anagyrus*).

Lycaenidae.

Spalgis epius is widespread, and on *Annona* particularly it is very numerous. It is responsible for a considerable destruction of *P. lilacinus*. No parasites of this Lycaenid were observed. It was successfully sent to Kenya in sealed tins in larval and pupal stages. I collected it in Buitenzorg, Malang, Bali and Lombok.

Noctuidae.

A species of *Eublemma* was seen to prey on *P. lilacinus* in Bali, though it is not believed that this mealybug is its chief prey. It is parasitised by a Braconid.

Coccinellidae.

The only coccinellid, of real importance, found preying on *P. lilacinus* was *Scymnus apiciflavus* Mots. This species was present in large numbers and is unquestionably an important factor in the destruction of mealybugs. It was collected in Buitenzorg, Malang, Djember, Bali and Lombok. It is easily reared in glass tubes in the laboratory. It was sent to Kenya in large numbers, and liberated, but it is not thought to be established there. It was observed to be parasitised by a species of *Homalotylus*. The biology of *Scymnus apiciflavus*, and that of a related species, *S. roepkei* de Fluiter, is dealt with at considerable length by de Fluiter (1941), who also records *Homalotylus oculatus* Girault as a parasite of these coccinellids.

Agromyzidae.

Larvae of an agromyzid were common among mealybug clusters in Java, particularly at Malang. No detailed observations on it were made, but it may prove to be an enemy of some importance.

Cecidomyidae.

The midge *Coccodiplosis pseudococci* de Meij. is common on *P. lilacinus* in the localities visited, having been collected in Buitenzorg, Malang, Djember, Bali

and Lombok; it appears to be of distinct importance as an enemy of *P. lilacinus* in Java. It is parasitised by what appears to be the same species of *Calliceras* as in Los Baños. *Copidosomopsis javensis* Girault is recorded as a parasite, probably of this midge (Girault 1919).

A second species of Cecidomyid, less common, was also found on *P. lilacinus* in Java.

ENCYRTIDAE.

Several species of *Anagyrus* were found to parasitise *P. lilacinus* in Java and these were the most important parasites during the period of my visit. There is a previous record of parasitism of *lilacinus* (*crotonis* Green) in Java by van der Goot (1917), who figures a species which is apparently an *Anagyrus*, possibly *nigricornis*; what is probably the same species was found, during my journey, at Buitenzorg.

This large and important genus of mealybug parasites presents very considerable taxonomic difficulties. A few species have characters separating them distinctly from other known species, but the majority are almost, or quite, indistinguishable by ordinary taxonomic methods. There is no doubt that in a section of the genus like that which includes *A. aurantifrons*, *kivuensis*, *lilacini*, and a number of other named and unnamed species, there are great biological differences, without comparable structural differences, these latter being either absent or so slight as to elude detailed and careful microscopic examination. At present, in order to employ species of this genus in biological control work, it is necessary to breed the insects and determine their value directly. As a result of future work, when the biology of the insects is better known, the taxonomic position may be clarified, but it seems likely that in order to distinguish species in this genus one may always require biological data.

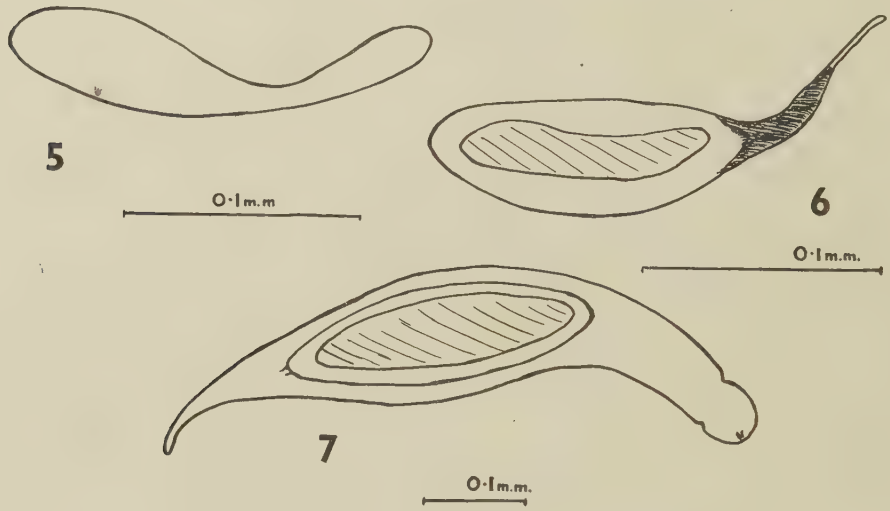
None of the several species of *Anagyrus* taken in Java has yet been identified definitely, but they are indicated herein by letters and it may be possible to give names of some of them at a later date.

(1) *Anagyrus* sp. (P). This is the most important parasite of *P. lilacinus* in Java. It was first discovered at Malang, but was also found at Buitenzorg, Djember, Bali and Lombok, and was particularly numerous at Malang. No detailed counts of the percentage of parasitism were made, but some collections were obviously so heavily attacked that it is almost certain that the insect is capable of completely wiping out infestations of the mealybug. From one shipment of approximately 4000 field-collected mealybugs, not specially selected as parasitised or mummified, 691 living adults of this parasite were obtained in Nairobi. The time from oviposition to emergence of the adult in the laboratory at Buitenzorg was from 21 to 23 days. The ovarian egg has a large " stalk " about half as large as the remainder of the egg (fig. 5); when laid it remains attached by the stalk to the skin of the mealybug (fig. 6). The larva four days after oviposition is shown in fig. 7.

(2) *Anagyrus* sp. (Q). A second species of the same genus, which may be *Anagyrus nigricornis*, was obtained. This insect was less common than the above, but numbers were obtained at Buitenzorg, and also in Bali and Lombok. In the few cases accurately determined the time from oviposition to emergence of the adult was 20 to 22 days. This insect was not an enemy of major importance during the period of the observations. It was successfully shipped to Kenya.

(3) *Anagyrus* sp. A species belonging to the group of *A. lilacini* Ferr., of

which there are a number of almost indistinguishable species in different parts of the world, including *A. aurantifrons*, *A. kivuensis* and several others, was found at Buitenzorg; it differs chiefly in slight antennal characters from *A. lilacini*. It was not of great importance at the time of my visit.



Figs. 5–7.—Eggs and larva of *Anagyrus* sp. (P).

(4) (5) *Anagyrus* spp. Two other species of this genus were obtained (S and V) from *P. lilacinus*, but they were rare. This is by far the most important genus of *P. lilacinus* parasites in Java and may in general be the most important genus of parasites of mealybugs in this island, as still other species of the genus were found parasitising other mealybugs.

(6) *Pseudaphycus* sp. A few specimens of what was taken to be *Pseudaphycus orientalis* were obtained from mealybugs (*P. lilacinus*) at Buitenzorg and Malang. During the period of my visit this insect was scarce and of no practical importance, and it may prove to be a new species.

(7) *Taftia* sp. This insect is very close to *T. saissetiae*, but may prove to be a different species; it was commonly associated with *P. lilacinus* and was collected in Buitenzorg, Malang and Bali. It was very numerous on *P. lilacinus* and also on an undescribed species of *Pseudococcus* which was found to be very commonly present with *P. lilacinus* on *Annona* fruits. This insect was described as *Pseudococcus lepelleyi* by Betrem (1937). Of twenty-two *P. lepelleyi* collected from fruit at random and dissected, fourteen contained stages of this parasite. I should assess this insect as of definite importance in the complex of insects associated with *P. lilacinus*.

Hyperparasites. A common insect (species R) was obtained from mummies of *P. lilacinus* and *P. lepelleyi*; it was suspected to be a hyperparasite of *Taftia* sp. and also probably on various *Anagyrus* species. It is very similar to, and possibly the same species as, an insect known from Uganda which parasitises *Leptomastix* sp. in various mealybugs. It is not an Encyrtid.

Another *Achrysopophagus* sp., possibly the same as that taken in Los Baños, was not uncommon. It is thought to be a hyperparasite, but no detailed study of it was made.

Two other species were taken in small numbers from mummies of *P. lilacinus*, and these are suspected to be hyperparasites.

In concluding the paragraphs on the complex of *lilacinus* enemies in the Netherlands East Indies, it should be emphasised that the fauna connected with this mealybug in Java is particularly rich; a large number of other insects were obtained which appeared to be connected with it, though time did not permit a study of them. I believe that a number of primary and probably a large number of secondary parasites still remain to be discovered in this area.

(*C*) *Ceylon.*

In Ceylon *P. lilacinus* has been recorded from a number of hosts and localities. Examination of the insect collected there, formerly called *Pseudococcus crotonis* (Green) and later synonymised with *P. lilacinus* Cockerell, leaves no doubt that these names are synonymous. Another mealybug very closely resembling *P. lilacinus* but not, apparently, identical was obtained on *Citrus medica* and the exact relationship of this insect remains uncertain. Nearly all the *P. lilacinus* material collected at Peradeniya was from *Annona muricata* and *Theobroma cacao*, but the mealybug, though common, is not present in such numbers as in Java.

The only previous records of enemies in Ceylon are believed to be those of Green (1922). He records *Spalgis epius*, and a small Dipteron which pupates within the body of its host. *Spalgis epius* was found at the time of my visit to be fairly common, but the Dipteron was not observed.

Coccinellidae.

The additional enemies obtained were four species of Coccinellidae, *Nephus* sp., possibly *oblongosignatus* Mulsant, *Scymnus* sp. and two others, none of which is of real importance. The *Scymnus* was parasitised by a species of *Homalotylus*.

Cecidomyidae.

One species of Cecidomyid was found on *P. lilacinus* and it is thought likely will prove to be *Coccodiplosis pseudococci*; it was parasitised by an insect similar to the *Calliceras* from Los Baños which may be the same species. A number of coccidivorous cecidomyids have been recorded from Ceylon (Barnes 1930) and the above insect may be one of them; one of these species, *Arthrocnodax walkeriana* Felt, was recorded from a *Pseudococcus* on coffee.

Encyrtidae.

Two Encyrtids were found, though more are doubtless present. One was a species of *Anagyrus* similar to *Anagyrus lilacini*, and the other a fairly common insect (species W) thought to be a primary parasite, but of which the exact status was not determined.

(*D*) *Southern India.*

In Southern India *P. lilacinus* was found to be common only at Coimbatore, where it had previously been recorded from a number of hosts. There is also a previous record of what was possibly this species (though according to Green not typical, see Ramakrishna Ayyar (1919)) from Alainanda, Vizagapatam district, and a record from coffee in Coorg (Mayne and Subramahanyam (1933)). I was not able to find this insect in Coorg at the time of

my visit in July 1937. *P. lilacinus* was collected in Mysore city, Kallar, Mangalore and Mahé, from which localities it had not, I believe, been recorded before. It cannot be considered as common an insect in Southern India, except possibly in the neighbourhood of Coimbatore, as it is in Java.

Little is known of enemies in India, but *Spalgis epius* and *Eublemma scitula* have been recorded as found on it (Ramakrishna Ayyar 1929). The former was fairly common on *P. lilacinus* at Coimbatore though less so than in Java; while a species of *Eublemma* was also found, but it was not an important predator.

COCCINELLIDAE.

Several species of coccinellids were numerous and exerted an appreciable influence on the mealybug population. The chief of these was *Hyperaspis maindroni* which was common on *P. lilacinus* on *Gliricidia maculata*. Another was a small species of *Nephus*, possibly *severini* Wse., which was common; and another unidentified coccinellid.

AGROMYZIDAE.

Larvae of an agromyzid fly identified as *Leucopis* (*Neoleucopis*) *luteicornis* Malloch (1929) were also found to prey on *P. lilacinus*, particularly when the mealybug was on *Ailanthus*, though the fly was more common as a predator on another species of mealybug on the same host.

CECIDOMYIDAE.

Two species of cecidomyids, as yet undetermined, were present as predators of *P. lilacinus*. Two species have been recorded (see Barnes 1930) on mealybugs from India, *Diadiplosis indica* Felt on *Pseudococcus filamentosus* and *Phenacoccus hirsutus*; and *Schizobremia malabarensis* Felt on *Ferrisia virgata*. Whether either of those obtained at Coimbatore was one of these is not known.

ENCYRTIDAE.

A species of *Anagyrus* was found, one of the group of *A. lilacini*, though apparently a different species, but it was not numerous.

Another parasite, a species of *Tetracnemus*, was common; no detailed study of it was made, but further work would probably prove it to be the chief enemy of *P. lilacinus* in Southern India. It seems likely that it may prove to be *Tetracnemus indicus* Ramakrishna, which has been recorded in Coimbatore as a parasite of *Pseudococcus citri* (Pruthi and Mani 1940).

The following table summarises the information on the parasites and predators obtained in the different areas searched.

SUMMARY.

(1) *Pseudococcus lilacinus* Cockerell is the valid name for the mealybug with which this paper deals. Differences between this insect and *Pseudococcus kenyae* Le Pelley are given.

(2) The mealybug was studied in the Philippine Islands, Netherlands East Indies, Malaya, Ceylon and Southern India. It is present also in Formosa. It was found to have a maximum altitude limit of approximately 3000 ft.

(3) The chief host-plants are *Annona muricata*, *Theobroma cacao*, *Psidium*

TABLE.

Parasites and predators of *P. lilacinus* observed in 1936–7.

	Los Baños	Buitenzorg	Malang	Djember	Bali	Lombok	Peradeniya	Coimbatore	Notes
ENCYRTIDAE									
Anagyrus lilacini	xxx[9]								
Anagyrus sp. (*lilacini* group)		x							
Anagyrus sp. (*lilacini* group)							x		
Anagyrus sp. (*lilacini* group)								x	
Anagyrus sp. (P)	x	xxx	xxx	xxx	xxx	xxx			
Anagyrus sp. (Q)		xx			x	x			
Anagyrus sp. (S)		x							
Anagyrus sp. (V)		x							
Pseudaphycus orientalis	xxx								May be *orientalis*
Pseudaphycus sp.		x	x						
Aphycus sp.	x								
Taftia saissetiae	xxx								May be *saissetiae*
Taftia sp.		xxx	xxx		x				
Tetracnemus sp.								x	
Achrysopophagus sp.	x								
Achrysopophagus sp.		x							
Achrysopophagus sp.						x			
Unidentified sp. (C)	x								Suspected hyper on *P. orientalis*
,, sp. (E)	x								Suspected hyper on *P. orientalis*
,, sp. (D)	x								Status unknown
,, sp. (G)	x								Status unknown
,, sp. (N)	x								Status unknown
,, sp. (J)	x								Suspected hyperparasite
,, sp. (H)	x								Suspected hyperparasite
,, sp. (W)							xx		Possibly primary parasite
,, sp. (X)		x							Hyperparasite
,, sp. (Y)		x							Hyperparasite
,, sp. (R)		x							Hyperparasite, not Encyrtid
LYCAENIDAE									
Spalgis epius	xxx	xxx	xxx		xxx	xxx	xx	xx	
NOCTUIDAE									
Eublemma sp.					x				
Eublemma sp.								x	
AGROMYZIDAE									
Leucopis luteicornis								xx	
Unidentified sp.			xx	x					
CECIDOMYIDAE									
Coccodiplosis pseudococci	xxx	xxx	xxx	xxx	x	x			
Unidentified sp.	xxx								
,, sp.		x							
,, sp.							x		
,, sp.								x	
,, sp.								x	
COCCINELLIDAE									
Platynaspis stictica philippensis	xx								
Aspidimerus tristis	xx								
Scymnus apiciflavus		xxx	xxx	xxx	xx	xx			
Hyperaspis maindroni								xxx	
Nephus sp. (*oblongosignatus*)	x								
Nephus sp. (*? severini*)								xx	
Scymnus sp.							xx		
Unidentified sp.							x		
,, sp.							x		
,, sp.								x	

[9] xxx Very common, present in nearly all collections.
xx Common, present in majority of collections.
x Usually uncommon, not found in majority of collections, but may occasionally be numerous.
A blank in any column does not necessarily indicate that the insect does not occur in the area, but that it was not observed at the time of the visit.

guajava, Ceiba pentandra among others, and in addition a number of other plants are listed which it is believed are new host records.

(4) A few ants associated with it are mentioned.

(5) The greater part of the paper is an account of insect enemies of this mealybug, and the results of this work are summarised in the table above.

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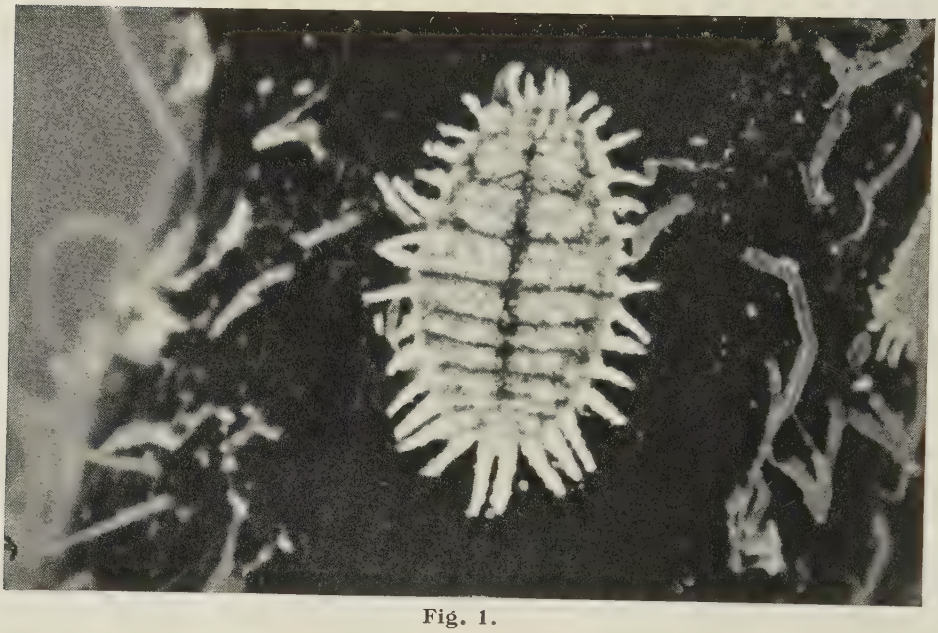
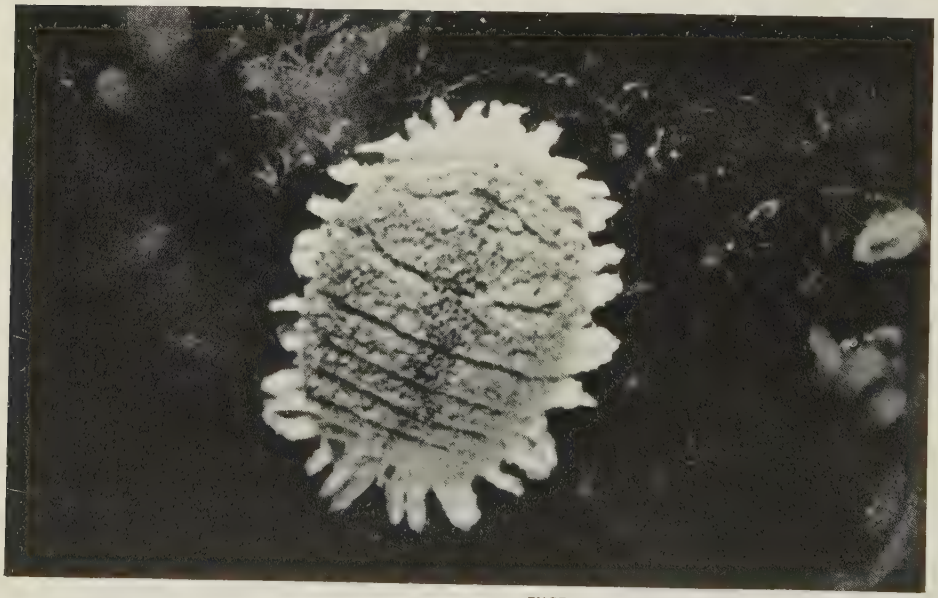


Fig. 1.



ENGRAVED BY STAR ILLUSTRATION, LONDON.

Fig. 2.

Fig. 1. **Pseudococcus kenyae,** *adult female* × 18.
Fig. 2. **Pseudococcus lilacinus,** *adult female* × 18.

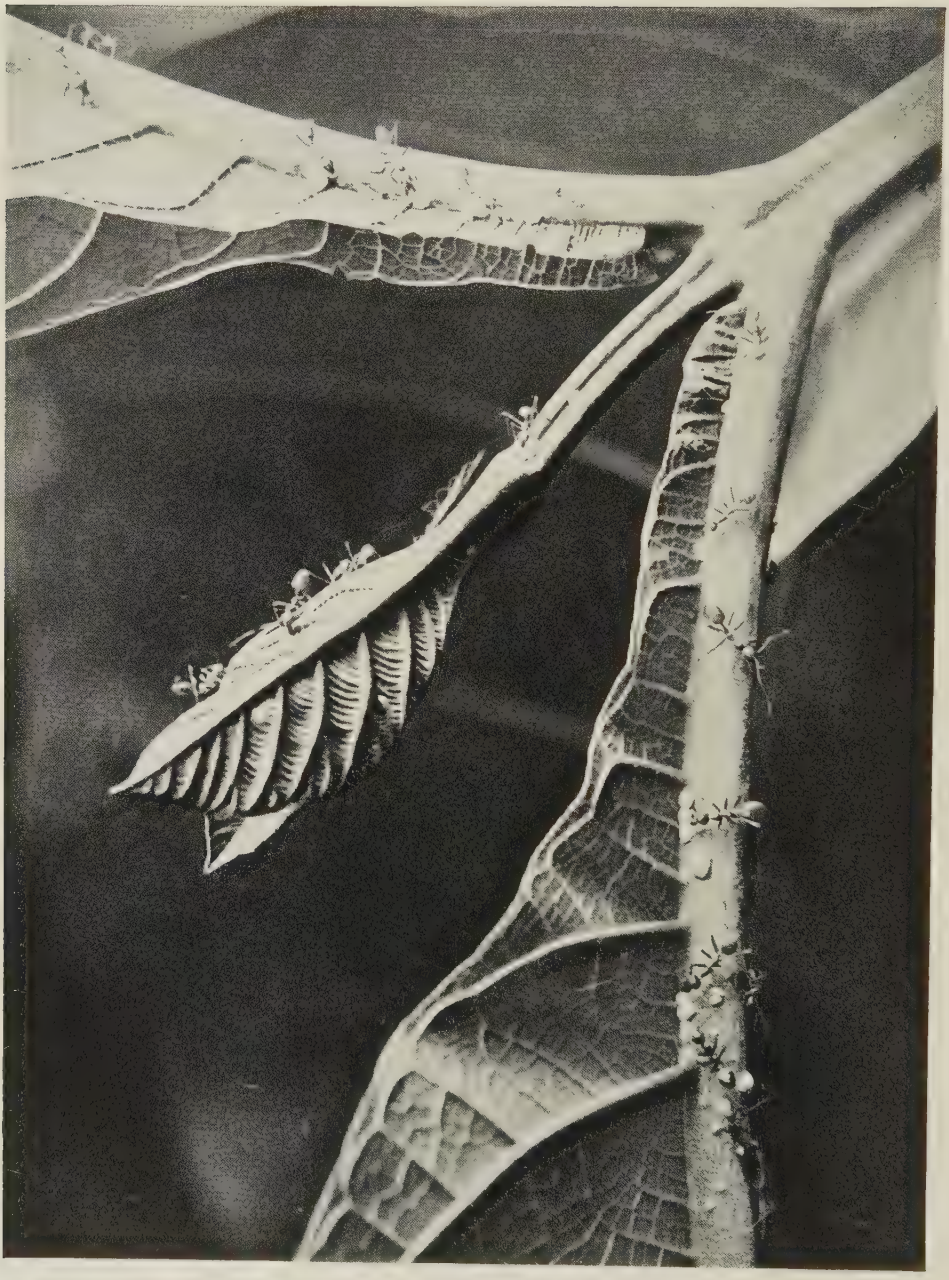


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Fig. 3.

P. lilacinus *on* **Tectona grandis** *attended by* **Oecophylla smaragdina.**

Fig. 4.

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Fig. 5.

Fig. 4. **P. lilacinus** *with wax removed by Ants. Insects parasitised by* **Pseudaphycus** *indicated by arrows.*

Fig. 5. **P. lilacinus,** *heavy attack on* **Bauhinia.**

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Fig. 6.

Fig. 6. **P. lilacinus,** *on fruit of* **Psidium guajava.**
Insects parasitised by **Taftia** *indicated by arrows.*

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Explanation of Plates 1–4.

Plate 1.

Fig. 1. *Pseudococcus kenyae*, adult female, × 18. Photograph of living insect by C. F. Fox.

2. *Pseudococcus lilacinus*, adult female, × 18. Reared in Nairobi from material collected in Coimbatore, India. Photograph of living insect by C. F. Fox.

Plate 2.

Fig. 3. *P. lilacinus* on *Tectona grandis* attended by *Oecophylla smaragdina.*

Plate 3.

Fig. 4. *P. lilacinus* with wax removed by ants. Insects parasitised by *Pseudaphycus* indicated by arrows.

5. *P. lilacinus*, heavy attack on *Bauhinia.*

Plate 4.

Fig. 6. *P. lilacinus*, on fruit of *Psidium guajava.* Insects parasitised by *Taftia* indicated by arrows.

NOTES ON THE BRITISH SPECIES OF ADELOGNATHINI ROMAN, WITH DESCRIPTIONS OF TWO NEW SPECIES (HYM. ICHNEUMONIDAE)

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With 17 Text-figures.

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1. Introduction.

In 1938, in the province of Skåne, south Sweden, I took two males and three females of an *Adelognathus* which appear to belong to an undescribed species. A little later, Mr. A. W. Stelfox sent to me for determination a single specimen of this same species from Ireland. Subsequently Mr. G. J. Kerrich sent me a series of four males and four females of this *Adelognathus*, bred by Dr. H. W. Miles from the Nematine sawfly, *Pristiphora pallipes* Lep. I am now describing this species, as host records are few for species of this tribe, though several of them have been recorded from unidentified sawfly larvae.

As several other additions to the list of British species of this tribe are made, I am including a key and descriptions of the species that are now known to me from this country. No doubt further British species will be found, as these are rather rare insects and not frequently collected. The British material at my disposal has in fact been very meagre, but I have used continental specimens to supplement the British in drawing up the keys and diagnoses. I have not attempted to deal with the males, for I have not been able to associate these satisfactorily with the females as there is considerable sexual dimorphism.

In 1938, I had the advantage of examining the Thomson Collection in the Lund University Museum, and there I determined specimens of all the previously described species included in this paper. I have, therefore, followed Thomson's interpretation of the older species except in two cases. First, Schmiedeknecht (1911) and Roman (1918) have shown that *Adelognathus* (*Notomeris*) *difformis* Holmgren (Thomson *nec* Holmgren) is distinct from *Adelognathus* (*Notomeris*) *difformis* Holmgren, and Schmiedeknecht has given the name *Adelognathus* (*Notomeris*) *thomsoni* to the former. Secondly, Roman (1918) published a key to the species of this tribe, from which I am certain that *Adelognathus limbatus* Thomson is a synonym of *Adelognathus brevicornis*

Holmgren. Roman also suggests that *Adelognathus nigricornis* Thomson is a synonym of *Adelognathus pusillus* Holmgren. If Thomson's interpretation of the latter species is correct (I have here used his interpretation), then these two species are quite distinct as will be seen from the key.

In the descriptions of the species I have used only those characters which I have found of most value in separating the species. In the key I have made considerable use of pubescence which previously has been little used in separating the species of this group, though Thomson indicated that there are good differences to be found in it. Certain of the species, too, have been found to have the mesonotum granulate, not punctured. This can only be clearly seen as granulation under a compound microscope, though under a lens (× 20) it appears as distinct sculpture; in working the key it is sufficient to see that the mesonotum is sculptured, and not the form of the sculpture. The pubescence characters, however, can be clearly seen with a magnification of × 20, though I have drawn up the descriptions using the higher powers of a binocular microscope.

Morley (1911) placed this genus in his sub-tribe Ctenopelmini of his tribe Tryphonides (subfamily TRYPHONINAE). Schmiedeknecht (1911) follows Thomson (1888) in placing it as a sub-tribe, Adelognathina, of the Plectiscini which he considered to belong to the OPHIONINAE. Roman (1918) erected a new tribe, the Adelognathini, for this genus and placed it in the CRYPTINAE, and near the Phygadeuonini. B. P. Beirne has examined the larvae of two species of *Adelognathus* and informs me that they are quite distinct from those of all other ICHNEUMONIDAE known to him, but have certain characters that would place them nearest to the CRYPTINAE, and it is probable that the tribe Adelognathini really forms a distinct subfamily, related to the CRYPTINAE. Whatever the true relationship of the tribe may be, it is readily distinguishable from all other British ICHNEUMONIDAE on the following characters :—

Antennae with 14, rarely 15, segments; labrum long and broad, always clearly visible and usually excised apically, rarely truncate; the upper tooth of the mandible a little stouter and longer than the lower; the 2nd cubital cell pentagonal, regular or irregular, the 2nd transverse cubitus sometimes absent; propodeum declivous from the apex of the basal area, the pronotum short, the mesonotum anteriorly sharply declivous, almost excised, the head closely appressed to the thorax. The antennae are almost always more or less thickened apically; the ovipositor of the ♀ is usually exserted, rarely concealed, but never long; the 1st tergite is sub-petiolate or petiolate; the transverse median vein of the hind-wings is antefurcal and broken well below the middle; the sternauli are usually very indistinct.

Morley (1911) recorded four species of *Adelognathus* from Britain. Carr (1924) added two more species which he had collected in the Lichfield district, viz. *Adelognathus laevicollis* Thoms. and *Adelognathus nigriceps* Thoms. In examining the Marshall Collection in the British Museum I have found a specimen of one further species, *Adelognathus pusillus* Holmgren, which had been wrongly determined as *Adelognathus pallipes* (Grav.) by Morley, and which Marshall had named *chrysopygus* (Grav.). In the past seven years I have received or collected two more species previously unrecorded from this country, *Adelognathus nigricornis* Thoms. and *Adelognathus* (*Notomeris*) *thomsoni* Schmied., as well as two species new to science (one of these being the species bred from *Pristiphora pallipes* Lep.). Thus there are eleven species now known from Britain.

I have accepted the division of *Adelognathus* into the sub-genera given by

Thomson (1888). It is probable that when more species are examined, the group will be divisible into a number of genera.

2. Keys to the British Adelognathini.

Keys to the sub-genera.

1. ♀ with the ventral membrane of the broader 1st abdominal segment extending forward to distinctly before the middle; of the ♂ always extending distinctly before the spiracles.
   (Scape less strongly excised apically; ♀ with the ovipositor although short, exserted, and with no sensory pit on the hind femur) . . . . 2.
–. ♀ with the ventral membrane of the narrow 1st abdominal segment extending forward to only about ⅓ the length of the segment; of the ♂ extending to the line of the spiracles.
   (Scape strongly excised apically, the excision extending almost to the middle of the segment, the pedicel distinctly longer than the shortest length of the scape; ♀ with the ovipositor concealed, and the hind femur with a dorso-lateral sensory depression at about the apical ⅕).
   Pammicra Förster, 1868.
   (One species *Adelognathus* (*Pammicra*) *dorsalis* (Grav.).)
2. Antennae with 15 segments.
   (Scape with a distinct apical excision to about ⅓ of the length of the segment; pedicel about as long as the shortest length of the scape.)
   Notomeris Förster, 1868.
   (One species *Adelognathus* (*Notomeris*) *thomsoni* Schmied.)
–. Antennae with 14 segments.
   (Scape little excised apically, at most to about ¼; pedicel shorter than the shortest length of the scape) . . . . . *Adelognathus* Holmgren 1855.

Förster described two further genera related to *Adelognathus*: *Synaema*, a synonym of *Adelognathus*, differing only in having the 2nd transverse cubitus "absent," and *Cnemischys* which Thomson retained as a sub-genus of *Adelognathus*, differing in the area spiracularis of the propodeum being partly closed behind, and the coarsely coriaceous-punctate 2nd abdominal tergite. This latter sub-genus has not yet been found in Britain. Thomson also placed his *Macrochasma*, which is a synonym of *Idiogramma* Förster, in the sub-tribe Adelognathina.

Key to the species of *Adelognathus*.

Females.

1. Genal sulcus present, fine, running from the eye to the angle between the clypeus and the base of the mandible; genal costa not inflexed
   nigriceps Thoms.
–. Genal sulcus absent (at most with a band of coriaceous sculpture on the cheek in this position); genal costa inflexed . . . . . 2.
2. 2nd tergite evenly, and more closely pubescent, with only the extreme base glabrous . . . . . 3.
–. 2nd tergite at least in part glabrous (as well as the extreme base), the pubescence, where present, sparse . . . . . 4.
3. Face entirely yellow, the frontal orbits to about ½ and the cheeks in part yellow; pronotum with the hind angles broadly, and the front margin towards the lower angles, yellow; sculpture less distinct—the frons centrally almost smooth, the pronotum with sculpture only towards the hind

angles; clypeus smooth, with no clearly differentiated apical margins; the abdominal segments narrowly white-margined posteriorly; the front and middle coxae yellow, the hind coxae black . . . *nigricornis* Thoms.

–. Face with the epistoma and the orbits only yellow, the frons entirely black, the cheeks black; pronotum only with a very small yellow mark in the extreme hind angle against the tegula; sculpture more distinct—the frons centrally with distinct granulations, the pronotum viewed laterally with the area anterior to the oblique depression irregularly striate, the striae running parallel with the anterior margin, the groove, dorsad, with strong, transverse striae, towards the hind margin somewhat costate or rugose; clypeus coriaceous, with a clearly differentiated smooth apical margin; only abdominal tergites 6–8 yellow apically; the coxae for the most part black, the hind trochanters fuscous *britannicus* sp. n.

4. Frontal orbits in part broadly yellow, the face and clypeus entirely black; the mesonotum for the most part glabrous, with the pubescence confined to a narrow area around the margins, and along the notauli (also there are a few hairs centrally and posteriorly along the line of the notauli which are only impressed to about $\frac{1}{3}$ the length of the mesonotum), scutellum with only lateral pubescence . . . . . *laevicollis* Thoms.

–. The face and clypeus either conspicuously marked with yellow, or entirely yellow (the frontal orbits with or without yellow markings); the mesonotum pubescent, with at most the lateral lobes in part glabrous . . . 5.

5. Frontal orbits black . . . . . 6.

–. Frontal orbits yellow, at least in the lower half . . . . . 7.

6. Head black with only the epistoma and clypeus yellow; the 13th antennal segment about $1\frac{1}{4}$ times as long as broad; clypeus, measured between the clypeal foveae, about twice the length of the clypeus; 2nd tergite with a median area of pubescence; 2nd segment of hind tarsus equal to the 5th . . . . . *brevicornis* Holmgr.

–. Head with the face and clypeus entirely yellow, the cheeks marked with yellow; the 13th antennal segment about twice as long as broad; clypeus, measured between the clypeal foveae, about $1\frac{3}{4}$ times the length of the clypeus; 2nd tergite with no median area of pubescence; 2nd segment of hind tarsus distinctly longer than the 5th *chrysopygus* (Grav.).

7. The mesonotum strongly granulate, the lateral lobes sometimes with the granulations weaker, evenly pubescent; the stigma pale testaceous with the margins narrowly fuscous; the hind tibiae not strongly inflated; propodeum with the petiolar and superomedial areas complete or almost complete; 2nd segment of hind tarsus conspicuously longer than the 5th . . . . . *granulatus* sp. n.

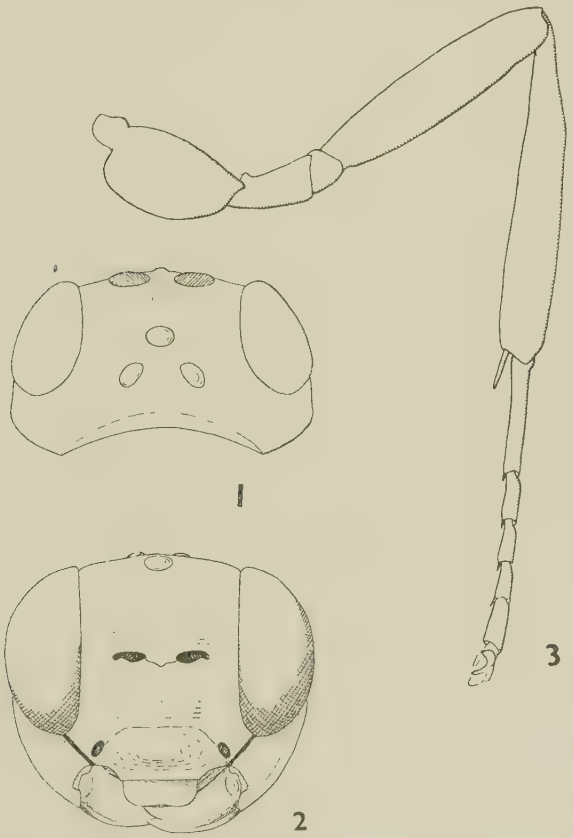
–. The mesonotum at most with few, scattered granulations, and if these are present then the lateral lobes of the mesonotum are glabrous centrally; the stigma fuscous; the hind tibiae very strongly inflated; the propodeum very smooth and with only the petiolar area represented posteriorly, and broadly open above; 2nd segment of hind tarsus equal to the 5th . . . . . 8.

8. Mesonotum with the lateral lobes glabrous centrally; the post-petiole a little longer than broad; the 2nd cubital cell closed, though the 2nd transverse cubitus may be unpigmented; mesonotum with sparse, small granulations centrally; prepectus clearly bounded by the raised epicnemia *pusillus* Holmgr.

–. Mesonotum with the lateral lobes evenly pubescent; the post-petiole a little broader than long; the 2nd cubital cell not closed, the 2nd transverse cubitus absent; mesonotum smooth; the prepectus indistinctly bounded by the very weak epicnemia . . . . . *pallipes* (Grav.).

3. Descriptions of Species.

The references given in the following descriptions are to those works which I have found to be of the most use in the determination of the species concerned. References to the species brought forward since Morley as new to the British list are also included. References to the original description of all the species are given. Except in the case of *Adelognathus* (*Pammicra*) *dorsalis* (Grav.), of which I have seen no British specimens, I have recorded only the British material that I have actually examined during the compilation of this paper. It should also be pointed out that Ichneumonids are very variable in length, and therefore the sizes given for the species are only approximate.



Figs. 1–3.—*Adelognathus nigriceps* Thoms. ♀: 1, head viewed from above; 2, head viewed from in front; 3, hind leg.

Adelognathus Holmgren 1855.

Adelognathus (*Adelognathus*) *nigriceps* Thoms.

1888. Thomson, *Opusc. Entom.* **12** : 1274.
1911. Schmiedeknecht, *Opusc. Ichn.* **4** : 2150.
1918. Roman, *Ark. Zool. Stockholm.* **12** (2) : 18.
1924. Carr, *Trans. N. Staffs. F. Cl. Stafford.* **58** : appdx.

♀. *Head.* The temples are a little widened behind the eyes (fig. 1): the genal sulcus is fine but quite deeply impressed, and runs from the lower margin of the eye to the

extreme outer angle of the clypeus (fig. 2): clypeus strongly convex, coriaceous, and with a distinct, smooth, apical margin; strongly transverse: antennae rather long, and little thickened apically, the penultimate segment about 1½ times as long as apically broad: the genal carina meeting the oral carina at the base of the mandible (*i.e.* not inflexed); the occipital carina strong, complete behind the ocelli, weakly angled towards the neck: face, and cheeks in part, strongly coriaceous; the epistoma strongly raised and strongly divided from the clypeus: the temples and the frons weakly, sparsely granulate, the sculpture of the frons being stronger towards the base of the antennae.

Thorax. Pronotum with the oblique lateral depression transcostate ventrad, becoming smooth dorsad, the area before this shining, sparsely granulate, and between the depression and the hind angle shining, weakly sculptured: mesonotum with the notauli very shallow, and weak even at the anterior margin; strongly polished centrally, granulate towards the anterior margin, with vague, shallow punctures towards the lateral margins, evenly pubescent: the mesopleurum smooth and shining: the mesosternum shining with vague, shallow punctures; the sternauli vaguely impressed anteriorly; the mesolcus strong, deepening posteriorly and closed; the prepectus margined by the strong epicnemia: scutellum polished, laterally closely pubescent, sparsely pubescent on the disc: propodeum strongly shining, the basal area open behind, the petiolar area only represented posteriorly, broadly open dorsally, only sculptured just above the base of the petiole: metapleurum weakly, sparsely granulate.

Legs. Hind tibia not strongly inflated, and less sharply constricted towards the base (fig. 3); the hind tarsus about as long as the hind tibia, with the 2nd segment a little shorter than the 5th (fig. 5).

Wings. The 2nd transverse cubitus present but unpigmented; the 2nd recurrent vein usually received nearer to the apex than the base of the 2nd cubital cell.

Abdomen. The 1st tergite short with the post-petiole a little transverse; the 2nd and 3rd tergites evenly pubescent; 2nd tergite with no oblique basal furrows.

Colour. Black: the face sometimes weakly marked with yellow, or testaceous towards the base of the antennae and the clypeus sometimes testaceous apically; the mandibles testaceous; the scape yellow beneath; the palpi yellow; the prothorax usually marked with testaceous or yellow anteriorly, towards the lateral angle; the extreme hind angle of the pronotum and the tegula, yellow; abdomen with the lateral margin, from the 2nd segment on, usually testaceous, the 5th tergite usually testaceous, the 6th and 7th yellow: legs pale testaceous with the femora darker, the coxae and tarsi for the most part black.

Length: 5 mm.

Localities. Devon: 1 ♀, Bishopsteignton (*T. A. Marshall*). Gloucestershire: 1 ♀, Staunton (High Meadow Woods), 5.vi.1936 (*E. B. Britton* and *J. F. Perkins*).

This species structurally is quite distinct from all other British species and might well be placed in a distinct sub-genus.

Adelognathus (*Adelognathus*) *nigricornis* Thoms.

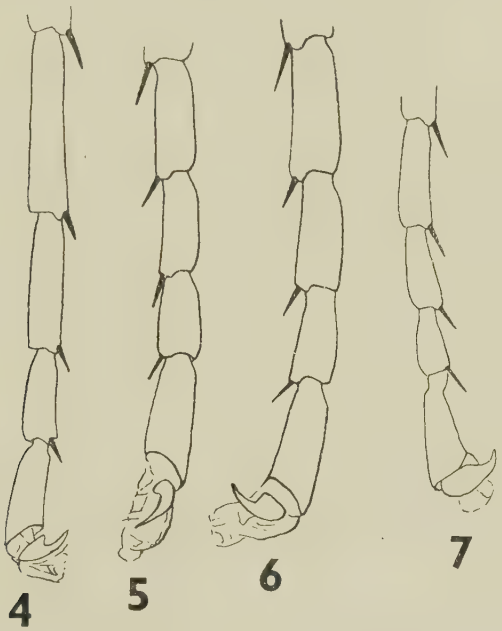
1888. Thomson, *Opusc. Entom.* **12**: 1276.
1911. Schmiedeknecht, *Opusc. Ichn.* **4**: 2155.

♀. *Head.* The temples a little narrowed behind the eyes: the genal sulcus absent: clypeus weakly convex, with no clearly differentiated apical margining, about twice as broad as long, smooth: antennae rather short, strongly thickened apically, the penultimate segment hardly longer than broad: the genal carina inflexed; the occipital carina evenly rounded and very narrowly interrupted centrally: epistoma raised and shining, almost smooth, the rest of the face, with the cheeks in part, coriaceous; the face strongly

divided from the clypeus: frons, except for the orbits, ventrad, and the temples almost smooth, with extremely small granulations at the base of the hairs.

Thorax. Pronotum smooth and shining, with irregular striae only towards the lateral angles: mesonotum smooth and shining, evenly pubescent, a little roughened towards the anterior margin; the notauli distinct and extending for about $\frac{1}{3}$ the length of the mesonotum: mesopleurum and mesosternum smooth; the sternauli absent; the mesolcus shallow anteriorly, deepening posteriorly and not closed; the prepectus is margined by the distinct epicnemia which is, however, weak centrally: scutellum polished, evenly pubescent: propodeum strongly shining with the basal area open behind and the petiolar area very broadly open above: metapleurum shining.

Legs. Hind tibia not strongly inflated, and not sharply constricted towards the base;



FIGS. 4–7.—Hind tarsal segments 2–5 of ♀ of: 4, *Adelognathus granulatus* sp. n.; 5, *Adelognathus nigriceps* Thoms.; 6, *Adelognathus brevicornis* Holmgr.; 7, *Adelognathus pusillus* Holmgr.

the hind tarsus a little longer than the hind tibia; hind tarsus with the 2nd segment distinctly longer than the 5th.

Wings. The 2nd transverse cubitus present, and usually in part pigmented; the 2nd recurrent received nearer to the apex than the base of the 2nd cubital cell.

Abdomen. The very fine granulation at the base of the hairs distinct, and thus appearing less highly polished; the 1st tergite widening evenly to the post-petiole, which is a little transverse; the 2nd and 3rd tergites are evenly pubescent except at the extreme base; the 2nd tergite with deep, oblique basal furrows.

Colour. Black: the following are pale yellow:—the face, clypeus, the cheeks between the eye and the base of the mandible, the mandible except for the apical teeth, the frontal orbits ventrad, the palpi, the anterior margin of the pronotum laterally, the hind angles of the pronotum, the tegula, the callus beneath the base of the wing, the extreme lateral margins of the abdominal tergites 2–6, the abdominal sternites; the apical margins of the abdominal segments usually white, or dirty white, those of the 6th and 7th broadly pale

testaceous: the legs very pale testaceous or yellow, with the femora darker, those of the hind legs frequently infuscate, the hind tibiae whitish, narrowly infuscate apically, all the tarsi fuscous, the hind coxae almost entirely black.

Length: 5 mm.

Localities. HERTFORDSHIRE: 1 ♀, Bricket Wood, 26.v.1936 (*R. B. Benson*).

This and the next species form a distinct group, characterised by the pubescence of the 2nd abdominal tergite which is fine and covers the segment except for the extreme base. *Adelognathus nigriceps* also has this character, but this species is quite distinct in the hind tarsi, the genal suture and the genal carina.

Adelognathus (Adelognathus) britannicus sp. n.

♀. *Head.* The temples parallel directly behind the eyes: the genal sulcus absent: clypeus strongly convex, coriaceous, with a broad apical margin which is smooth and shining, transverse: antennae rather short, thickened apically, with the penultimate segment about 1¼ times as long as broad: the genal carina inflexed; the occipital carina complete, somewhat angled centrally towards the ocelli: face and the cheeks in part coriaceous, the epistoma strongly raised, the clypeus distinctly divided from the face: the temples very finely granulate, the frons distinctly granulate, the sculpture strong laterally towards the base of the antennae.

Thorax. Pronotum with the oblique lateral depression transcostate, becoming rugose ventrad, the area before this irregularly striate, the striae more or less parallel with the anterior margin, the area between the depression and the posterior margin in part costate or rugose: mesonotum with the notauli distinctly impressed but rather short, about ⅓ the length of the mesonotum; strongly shining, with more or less distinct sculpture towards the anterior margin, evenly pubescent: mesopleurum shining, with distinct though shallow punctures dorsad: mesosternum with vague, irregular punctures; the sternauli weakly impressed anteriorly; mesolcus strongly impressed, deeper and wider posteriorly where it is transcostate, but not distinctly closed; prepectus margined by the strong epicnemia: scutellum polished, closely pubescent laterally, sparsely pubescent centrally: propodeum a little sculptured, not strongly shining, the basal area only visible as a pair of basal tubercles, open behind, petiolar area broadly open above: metapleurum, in part, weakly granulate.

Legs. Hind tibia not strongly inflated and not sharply constricted towards the base; the hind tarsus distinctly longer than the hind tibia, and with the 2nd segment distinctly longer than the 5th.

Wings. The 2nd transverse cubitus present but unpigmented; the 2nd recurrent received in the apical half of the 2nd cubital cell.

Abdomen. Strongly shining, the 2nd tergite with vague, shallow punctures and with rather weak oblique basal furrows, evenly pubescent except for the extreme base (fig. 8); the 1st tergite long, not sharply widening to the post-petiole which is subquadrate, a little transverse.

Colour. Black: only the following are pale yellow:—the epistoma centrally, the facial orbits broadly, the clypeus centrally, the mandibles in part, the extreme hind angle of the pronotum in front of the tegula, the tegula; the palpi are fuscous; the 1st tergite sometimes has a very small, dirty white, apical spot, the 6th to 8th tergites testaceous; the epipleura of the anterior segments yellow: the sternites yellow with the chitinised areas black, the apical sternite black: the legs pale testaceous with the femora darker, the hind tibiae hardly darkened at the extreme apex, the tarsi infuscate, the coxae black, the front and middle trochanters infuscate basally, the hind trochanter almost entirely black dorsally.

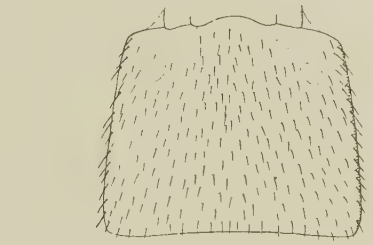
Length: 4–5 mm.

Type. ♀, GLOUCESTERSHIRE: Staunton (High Meadow Woods), 4.vi.1936 (*E. B. Britton* and *J. F. Perkins*).

Co-type. 1 ♀ GLOUCESTERSHIRE: Staunton (High Meadow Woods), 11.vi.1936 (*E.B.B.* and *J.F.P.*).

The type and co-type are in the British Museum (Natural History). The male is unknown.

This species is related, in the form of the pubescence of the second tergite, to *Adelognathus nigricornis* Thomson. It can be distinguished at once from that species by the characters given in the key.



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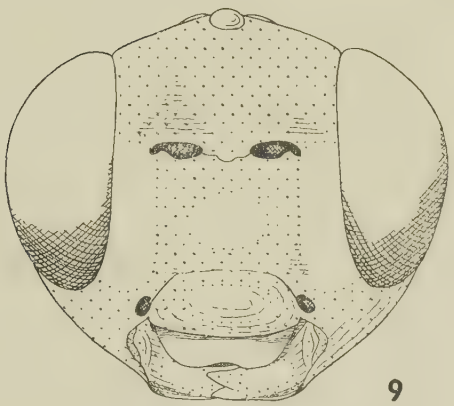

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FIGS. 8–9.—*Adelognathus britannicus* sp. n. ♀: 8, 2nd tergite; 9, head viewed from in front.

Adelognathus (*Adelognathus*) *laevicollis* Thoms.

1883. Thomson, *Opusc. Entom.* **9**: 878.
1888. ——, *Ibid.* **12**: 1275.
1911. Schmiedeknecht, *Opusc. Ichn.* **4**: 2151.
1918. Roman, *Ark. Zool. Stockholm.* **12** (2): 13.
1924. Carr, *Trans. N. Staffs, F. Cl. Stafford.* **58**: appdx.

♀. *Head.* The temples parallel directly behind the eyes: the genal sulcus absent: the clypeus strongly convex, smooth and shining, with a strong, flat, smooth, apical margin; transverse: the antennae rather short, the penultimate segment about 1¼ times as long as broad: the genal carina inflexed; the occipital carina weak centrally, weakly angled towards the neck behind the ocelli: the face and the cheeks in part coriaceous; the epistoma quite strongly raised, and divided by a distinct groove from the clypeus: temples and frons highly polished, the frons with only weak sculpture laterally towards the base of the antennae.

Thorax. Pronotum with the oblique lateral depression irregularly costate, otherwise

smooth and shining: mesonotum with the notauli distinctly impressed to about ¼ the length of the mesonotum; highly polished, weakly punctate towards the anterior margin; glabrous, with pubescence only on the margins, and along the line of the notauli: mesopleurum strongly shining, with few scattered shallow punctures dorsad: mesosternum strongly shining with shallow punctures; sternauli faintly indicated anteriorly; mesolcus deeply impressed, a little deeper posteriorly and closed by a low carina; prepectus distinctly margined by the strong epicnemia: scutellum polished, with sparse lateral pubescence, glabrous centrally: propodeum polished, sparsely granulate apically and laterally, the basal area only represented by a pair of basal tubercles, the petiolar area very broadly open above: metapleurum with sparse granulations.

Legs. Hind tibia inflated, but not sharply constricted at the base; the hind tarsus a little longer than the hind tibia, with the 2nd segment distinctly longer than the 5th.

Wings. The 2nd transverse cubitus present, usually pigmented in part; the 2nd recurrent received in the apical half of the 2nd cubital cell.

Abdomen. Polished: the 2nd tergite with bands of sparse, coarse pubescence laterally (widened near the base) and apically (narrowly), with a central area of fine pubescence, and having a glabrous area on each side of this, the base glabrous, the oblique furrows at the base distinct; the 1st tergite rather short, the petiole not sharply widening to the post-petiole, which is quadrate.

Colour. Black: the following are pale yellow:—the frontal orbits ventrad (broadly), the palpi, the hind angle of the pronotum and the tegula, the epipleura, the abdominal sternites; the abdominal tergites are usually very narrowly dirty white along the hind margin, and more broadly laterally on the 3rd and following tergites: legs with the coxae black, in part yellow apically, the trochanters yellow, the femora testaceous, those of the middle and hind legs conspicuously marked with fuscous, the tibiae white, internally testaceous, those of the hind legs very narrowly testaceous at the extreme apex outwardly, the tarsi sometimes in part testaceous, usually infuscate.

Length: 5 mm.

Localities. HEREFORDSHIRE: 1 ♀, Fownhope (Copler Wood), 31.v.1936 (*E. B. Britton* and *J. F. Perkins*). HERTFORDSHIRE: 1 ♀, Bricket Wood, 9.vi.1936 (*R. B. Benson*).

This species is quite distinct from all other known species, in the almost entirely glabrous mesonotum, and the pale markings of the head. The only other British species that approaches *Adelognathus laevicollis* in the pubescence of the mesonotum is *Adelognathus pusillus* Holmgr., and in this only the lateral lobes are in part glabrous: it also has the entire face and lower frontal orbits yellow. The glabrous areas of the second tergite of *Adelognathus laevicollis* are smaller than in most of the following species, and care must be taken to distinguish it from the preceding two species. However, those two species have an even pubescence over the whole segment, while in this species the pubescence of the central patch is closer, shorter and finer than that of the bands towards the margins of the segment.

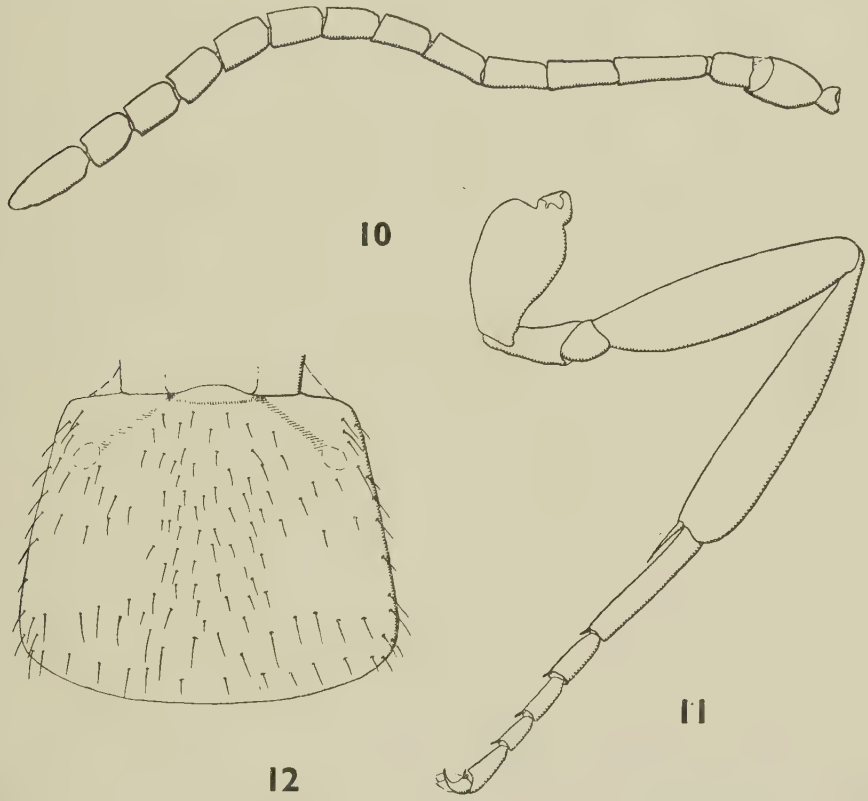
Adelognathus (*Adelognathus*) *brevicornis* Holmgren.

1855. *Adelognathus brevicornis* Holmgren, *Sv. Vet. Akad. Handl.* **1**: 197.
1888. *Adelognathus limbatus* Thomson, *Opusc. Entom.* **12**: 1275.
1909. *Adelognathus brevicornis* Holmgr., Morley, *Brit. Ichn.* **4**: 317.
1911. *Adelognathus brevicornis* Holmgr., Schmiedeknecht, *Opusc. Ichn.* **4**: 2150.
1911. *Adelognathus limbatus* Thoms., Schmiedeknecht, *Opusc. Ichn.* **4**: 2153.
1918. *Adelognathus brevicornis* Holmgr., Roman, *Ark. Zool. Stockholm.* **12** (2): 13.

♀. *Head.* The temples parallel directly behind the eyes: the genal sulcus absent: clypeus finely coriaceous, convex, sharply impressed towards the narrow, smooth, apical

margin; transverse but not strongly so: antennae short, strongly thickened apically, the penultimate segment a little longer than broad (fig. 10): the genal carina inflexed; the occipital carina complete, centrally weakly inflexed towards the neck: the face and the cheeks in part coriaceous; epistoma strongly raised, distinctly divided from the clypeus by a depression: temples and the frons finely sparsely granulate; the frons with strong coriaceous sculpture along the orbits ventrad.

Thorax. Pronotum with the oblique lateral depressions transcostate dorsad, irregularly striate ventrad, weakly sculptured, before the depression shining; posteriorly,



FIGS. 10–12.—*Adelognathus brevicornis* Holmgr. ♀: 10, antennae; 11, hind leg; 12, 2nd tergite.

towards the hind angles, smooth and shining: mesonotum shining, anteriorly distinctly sculptured, laterally with indistinct, coarse, very shallow punctures: mesopleurum shining with a few scattered shallow punctures dorsad: mesosternum shining, with indistinct, very shallow punctures; the sternaulus very weak and just discernible anteriorly; the mesolcus quite strongly impressed, only a little deeper posteriorly and not closed; the prepectus margined by the strong epicnemia: scutellum polished, strongly pubescent laterally, and with a small glabrous central area: propodeum shining, in part finely granulate, weakly sculptured posteriorly just above the base of the petiole; the basal area only represented by a pair of tubercles, the petiolar area broadly open above: metapleurum strongly shining, at most with very indistinct sculpture.

Legs. Hind tibia rather strongly inflated, quite sharply constricted towards the base

(fig. 11); the hind tarsus a little longer than the hind tibia, with the 2nd segment equal to the 5th (fig. 6).

Wings. The 2nd transverse cubitus present but not pigmented; the 2nd recurrent received near the apex of the 2nd cubital cell.

Abdomen. Polished: the 2nd tergite with scattered, coarse hairs towards the lateral margins, apically and towards the base, and with a central area of fine closer pubescence; on each side of this central area there is a distinct glabrous area; the extreme base is glabrous: the oblique impressions at the base of the 2nd tergite are very strong (fig. 12): the 1st tergite broad, short, the petiole rather abruptly widened to the post-petiole which is transverse.

Colour. Black: the following are yellow:—the epistoma, the clypeus, the mandibles (except apically), the palpi, the scape beneath, the anterior margin of the pronotum towards the lower angle, the hind angle of the pronotum in front of the tegula, the tegula, the callus beneath the fore-wing, the epipleura (those of the apical segments sometimes somewhat infuscate), the apical margins of the abdominal tergites broadly (except the 1st): the abdomen usually with the 3rd and following segments more or less testaceous laterally, the sternites yellow sometimes with the sclerotised areas infuscate and the last sternite frequently infuscate at least in part: the legs with the coxae yellow, those of the hind leg broadly testaceous or infuscate at the base, the 1st and 2nd trochanters yellow, the femora testaceous, the tibiae testaceous, usually narrowly white externally with those of the hind legs always broadly white externally and narrowly fuscous apically, the tarsi infuscate.

Length: 5 mm.

Localities. DEVONSHIRE: Newton Abbot, 1 ♀, 1.vi.1941 (*J. F. Perkins*): HAMPSHIRE: Hengistbury Head, 3 ♀♀, 3.vi.1938 (*R. B. Benson*). HERTFORDSHIRE: Bricket Wood, 1 ♀, 9.vi.1936, 2 ♀♀, 19.vi.1936 (*R.B.B.*). SOMERSETSHIRE: Porlock district, 1 ♀, 24.v.1934 (*J.F.P.*).

This appears to me to be one of the commonest European species of this genus. *Adelognathus brevicornis* can be distinguished from all the following species by the presence of the central area of fine pubescence. In this it agrees with *Adelognathus laevicollis*, from which it can be separated at once by the mesonotum, which is entirely covered with pubescence, and also by the pale markings of the head.

Adelognathus (*Adelognathus*) *pusillus* Holmgr.

1855. Holmgren, *Sv. Vet. Akad. Handl.* **1**: 198.
1883. Thomson, *Opusc. Entom.* **9**: 879.
1888. ——, *Ibid.* **12**: 1277.
1911. Schmiedeknecht, *Opusc. Ichn.* **4**: 2156.
1918. Roman, *Ark. Zool. Stockholm.* **12** (2): 12.

♀. *Head.* The temples very slightly diverging behind the eyes: the genal sulcus absent: clypeus finely coriaceous, convex, with a distinct, smooth apical margin; a little transverse: antennae rather long, a little thickened apically, the penultimate segment about 1½ times as long as broad: the genal carina inflexed; the occipital carina weak centrally, and angled towards the neck: the face and the cheeks in part coriaceous; epistoma strongly raised and distinctly divided from the clypeus by a depression: temples and frons smooth and shining, the frons coriaceous ventrad along the orbits.

Thorax. Pronotum with the lateral oblique furrow transcostate dorsad, irregularly striate ventrad, the areas before and behind this smooth and shining: mesonotum shining, the hairs arising in part from sparse minute granulations, which are closer along the anterior margin; evenly pubescent except for the central areas of the lateral lobes which are glabrous; the notauli strong, reaching almost to the middle of the mesonotum:

mesopleurum smooth and shining with a very few, scattered, shallow punctures dorsad: the mesosternum polished; the sternaulus absent; the mesolcus not deeply impressed, becoming only a little deeper posteriorly, transcostate; the prepectus margined by a strong epicnemia: scutellum polished, sparsely pubescent laterally, glabrous centrally: propodeum shining, very finely and sparsely granulate posteriorly; the basal area open behind, the petiolar area broadly open above: the metapleurum sparsely granulate.

Legs. The hind tibia strongly inflated, sharply constricted towards the base (fig. 13); the hind tarsus longer than the hind tibia, with the 2nd segment equal to the 5th (fig. 7).

Wings. The 2nd transverse cubitus present, usually pigmented; the 2nd recurrent received approximately in the middle of the 2nd cubital cell.

Abdomen. Polished: the 2nd tergite with scattered hairs towards the base, laterally and apically; centrally glabrous; the oblique basal furrows strong and deep: the 1st tergite long, the petiole evenly widening into the post-petiole which is a little elongate.

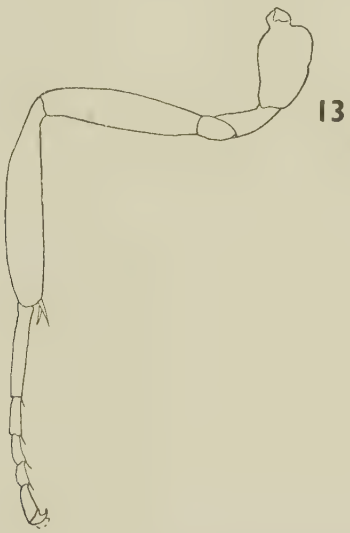


Fig. 13.—*Adelognathus pusillus* Holmgr. ♀: hind leg.

Colour. Black: the following are yellow:—the face, the clypeus, the cheeks in part, the frontal orbits in the lower $\frac{2}{3}$, the palpi, the scape beneath, the anterior margin of the pronotum towards the lateral angles (conspicuously and broadly), the hind angles of the pronotum (broadly), the tegula, the callus beneath the fore-wings; the abdomen with the apex of the 1st tergite narrowly white, apices of the remaining tergites broadly yellow, the lateral margins of the 3rd and following tergites broadly yellow or pale testaceous, the epipleura yellow, the sternites yellow, with the sclerotised areas sometimes in part infuscate: legs with the fore and middle coxae white, the hind coxae testaceous sometimes white apically and usually in part infuscate towards the base, the 1st and 2nd trochanters white, the femora testaceous, sometimes white towards the base and apex, the hind femora usually, at least in part fuscous, the tibiae white externally, testaceous internally, of the hind legs narrowly fuscous apically, the tarsi infuscate.

Length: 4–5 mm.

Localities. Wiltshire: Nunton, 1 ♀ (*T. A. Marshall*). (This specimen was determined as *Adelognathus chrysopygus* by Marshall, and subsequently recorded as *Adelognathus pallidipes* (Grav.) by Morley (det. Morley iii.1911).)

Adelognathus (*Adelognathus*) *chrysopygus* (Grav.).

1829. *Hemiteles chrysopygus* Gravenhorst, *Ich. Eur.* **2** : 839.
1883. *Adelognathus chrysopygus* (Grav.), Thomson, *Opusc. Entom.* **9** : 879.
1888. *Adelognathus chrysopygus* (Grav.), Thomson, *Opusc. Entom.* **12** : 1276.
1909. *Adelognathus chrysopygus* (Grav.), Morley, *Brit. Ichn.* **4** : 317.
1911. *Adelognathus chrysopygus* (Grav.), Schmiedeknecht, *Opusc. Ichn.* **4** : 2155.
1918. *Adelognathus chrysopygus* (Grav.), Roman, *Ark. Zool. Stockholm.* **12** (2) : 14.

♀. *Head.* Temples nearly parallel, slightly widened directly behind the eyes: the genal sulcus absent: clypeus shining, with very indistinct sculpture, convex but not strongly so, a little transverse: antennae long and little thickened apically, the penultimate segment twice as long as broad: the genal carina inflexed; the occipital carina strong, and evenly rounded dorsally: epistoma strongly raised and rather weakly divided from the clypeus by a depression; the face and the cheeks in part finely coriaceous: temples and frons sparsely granulate, the frons with only weak coriaceous sculpture along the orbits towards the base of the antennae.

Thorax. Pronotum with the oblique lateral depression transcostate, coriaceous towards the lower angles; smooth and shining before the depression, weakly coriaceous behind it, becoming smoother towards the hind angles: mesonotum shining, on the central lobe with sparse, distinct fine granulations, strongly punctate anteriorly, and with shallow irregular punctures on the lateral lobes, the disc usually finely coriaceous; the notauli strong and deep, extending to about the middle of the mesonotum; evenly pubescent: mesopleurum shining with irregular sparse punctures dorsad and sometimes a little coriaceous anteriorly, ventrad: the mesosternum with irregular very shallow punctures; the sternaulus indicated anteriorly; the mesolcus strongly impressed, deepening posteriorly where it is distinctly closed; the prepectus margined by the strong epicnemia: scutellum polished, closely pubescent laterally, sparsely pubescent centrally: propodeum shining, sparsely granulate, with the basal area distinct, open behind, sometimes almost joining the petiolar area which is narrowly open above, the area bounded by these carinae at least in part coriaceous: the metapleurum distinctly granulate.

Legs. The hind tibia strongly inflated, strongly constricted towards the base; the hind tarsus longer than the hind tibia, with the 2nd segment longer than the 5th.

Wings. The 2nd transverse cubitus present but unpigmented; the 2nd recurrent received about in the middle of the 2nd cubital cell.

Abdomen. Polished: the 2nd tergite with a row of sparse hairs at the basal $\frac{1}{3}$, this row does not reach the lateral marginal band of sparse hairs, also there is an apical transverse band of sparse hairs; with the oblique basal furrows strong and deep: the 1st tergite rather short, the petiole rather sharply widening into the post-petiole which is a little broader than long.

Colour. Black: the following are bright yellow:—the face, the clypeus, the cheeks broadly, the palpi, the scape (which is sometimes fuscous dorsally), the anterior margin of the pronotum, the lateral angles of the pronotum broadly (sometimes in part testaceous in this area), the hind angles of the pronotum broadly, the tegula, the prosternum (at least broadly apically); the abdomen usually with the apex of the 1st tergite narrowly, of the 2nd and 3rd broadly, testaceous, and the following tergites entirely testaceous, rarely much less conspicuously marked with testaceous, the epipleura and sternites bright yellow: the fore and middle legs pale yellow, the femora sometimes in part testaceous, the tibiae outwardly narrowly white and the apical tarsal segments sometimes infuscate, the hind legs testaceous with the 1st and 2nd trochanters pale yellow, the hind tibiae outwardly white, and the tarsi in part infuscate.

Length: 5 mm.

Localities. KENT: Goudhurst, 1 ♀, 13.viii.1935 (*O. W. Richards*). NORTHAMPTONSHIRE: Bugbrook, 1 ♀ (*T. A. Marshall*).

This, and the following species, usually have the apex of the abdomen broadly testaceous, the hairs of the 2nd tergite very sparse, with a large glabrous central area, and the prosternum entirely or apically broadly yellow. Superficially *A. chrysopygus* may be distinguished from the two following species by its entirely black frons.

Adelognathus (*Adelognathus*) *pallipes* (Grav.).

1829. *Plectiscus pallipes* Gravenhorst, *Ich. Eur.* **2** : 981.
1883. *Adelognathus pallipes* (Grav.), Thomson, *Opusc. Entom.* **9** : 878.
1888. *Adelognathus pallipes* (Grav.), Thomson, *Opusc. Entom.* **12** : 1277.
1909. *Adelognathus pallidipes* Morley (emendation of *pallipes* Grav.), Morley, *Brit. Ichn.* **4** : 316.
1911. *Adelognathus pallipes* (Grav.), Schmiedeknecht, *Opusc. Ichn.* **4** : 2155.
1918. *Adelognathus pallipes* (Grav.), Roman, *Ark. Zool. Stockholm.* **12** (2) : 14.

♀. *Head.* The temples parallel directly behind the eyes : the genal sulcus absent : clypeus shining, without sculpture, convex, but not strongly so, not strongly transverse : the antennae long, little thickened apically, with the penultimate segment about twice as long as broad : the genal carina inflexed; the occipital carina distinctly interrupted centrally : the epistoma strongly raised, rather weakly divided by a depression from the clypeus; the face and cheeks in part weakly coriaceous : the temples and frons almost entirely smooth.

Thorax. Pronotum laterally smooth and shining : the mesonotum smooth and shining, evenly pubescent, the notauli extending to about $\frac{1}{3}$ the length of the mesonotum : the mesopleurum and mesosternum smooth and shining; the sternaulus absent or faintly indicated by a very shallow broad depression anteriorly; the mesolcus distinctly impressed, a little deeper posteriorly, and weakly closed behind; the prepectus not strongly bounded by the epicnemia which is frequently only present dorsad : scutellum polished, closely pubescent laterally, sparsely pubescent centrally : propodeum polished, with the basal area only represented by two lateral tubercles and the petiolar area very broadly open above : the metapleurum weakly granulate.

Legs. The hind tibia strongly inflated, rather sharply constricted towards the base; the hind tarsus longer than the hind tibia, with the 2nd segment equal to the 5th.

Wings. The 2nd transverse cubitus absent.

Abdomen. Polished : the 2nd tergite sparsely pubescent in the basal $\frac{1}{3}$ and apically, more closely pubescent along the lateral margins; with the oblique basal furrows strong and deep : the 1st tergite short, the petiole widening rather sharply to the post-petiole which is transverse.

Colour. Black : the following are bright yellow :—the face, the clypeus, the cheeks broadly, the mandibles (except the testaceous apical teeth), the frontal orbits, the scape beneath, the anterior margin and the hind angles of the pronotum broadly, the prosternum, the tegula; the abdomen usually with the apices of segments 1 to 3 narrowly, and the lateral margins of segments 2 and 3, testaceous, also the following segments testaceous, the 4th segment usually with a black central area at the base; the epipleura and sternites bright yellow : the front and middle legs very pale yellow, with the femora sometimes in part testaceous and the tarsi usually infuscate; the hind leg with the coxa, trochanter and trochantellus very pale yellow, the femur testaceous, very pale yellow basally and apically, the tibia white, testaceous internally, the tarsi infuscate.

Length : 5–6 mm.

Localities. Devonshire : Newton Abbot, 1 ♀, 10.vi.1941 (*J. F. Perkins*). Monmouthshire : Abergavenny, 1 ♀, 31.vii.1936 (*N. D. Riley*). Oxfordshire : Bagley Wood, 2 ♀♀, bred from tenthredinid larva, v.1925 (*O. W. Richards*).

This species can be distinguished from the other species of the genus found

in Britain by the very weak epicnemia which is usually absent ventrally. From *Adelognathus chrysopygus* it can be distinguished also by the yellow frontal orbits, and from *Adelognathus granulatus* by the smooth mesonotum.

Adelognathus (Adelognathus) granulatus sp. n.

♀. *Head.* Temples parallel directly behind the eyes: the genal sulcus absent: clypeus shining, weakly, sparsely granulate, convex, with a distinct though narrow, flat, apical margin; about 1½ times as broad as long: the antennae long, not conspicuously thickened apically, the penultimate segment about twice as long as broad (fig. 14): the genal carina inflexed; the occipital carina centrally angled towards the neck: the epistoma strongly raised, divided by a depression from the clypeus; the face, and the cheeks in part, coriaceous: the temples, the vertex behind and the frons dorsad, granulate; the frons coriaceous laterally ventrad.

Thorax. Pronotum with the oblique lateral depression transcostate; the area before this with striae running parallel with the anterior margin; the area between the depression and the hind angles more or less granulate and sculptured, smooth centrally: mesonotum strongly granulate, the granulations closer anteriorly; the notauli strong and deep, extending to about the middle of the mesonotum which is evenly pubescent: mesopleurum shining, weakly granulate dorsad, anteriorly and ventrad, the mesopleural groove distinct anteriorly: the mesosternum weakly, sparsely granulate; the sternaulus represented by a distinct anterior pit; the mesolcus strongly impressed, transcostate, closed behind; the prepectus margined by the strong epicnemia: scutellum polished, evenly pubescent: propodeum sub-rugose, not strongly shining, the petiolar area complete, and usually the dorsal areas indicated, at least in part: metapleura sub-rugose.

Legs. The hind tibia not strongly inflated, and not strongly constricted towards the base (fig. 15); the hind tarsus longer than the hind tibia, the 2nd segment distinctly longer than the 5th (fig. 4).

Wings. The 2nd transverse cubitus entirely missing (fig. 16).

Abdomen. The 1st tergite coarsely, longitudinally striate in apical half, the petiole widening quite sharply to the post-petiole, which is a little transverse; the rest of the abdomen strongly shining, the 2nd tergite with deep, oblique, basal furrows, sometimes with longitudinal striations towards the base.

Colour. Black: the following are yellow:—the face, the frontal orbits, the cheeks (at least in part), the scape beneath, the palpi, the anterior margin of the pronotum laterally, the hind angles of the pronotum, the prosternum, the tegula, the callus beneath the front wings; the abdomen, apically testaceous marked with yellow, the extent of the markings variable; also some specimens have the pale markings more yellow, others more testaceous, usually with the 3rd tergite pale testaceous laterally and apically, the 4th testaceous centrally and basally, yellow laterally and apically, and the remaining apical tergites yellow; the epipleura and sternites pale yellow: the legs pale yellow, usually with the coxae, and the tibiae internally and apically, marked with testaceous, and the femora entirely testaceous, the tarsi usually infuscate.

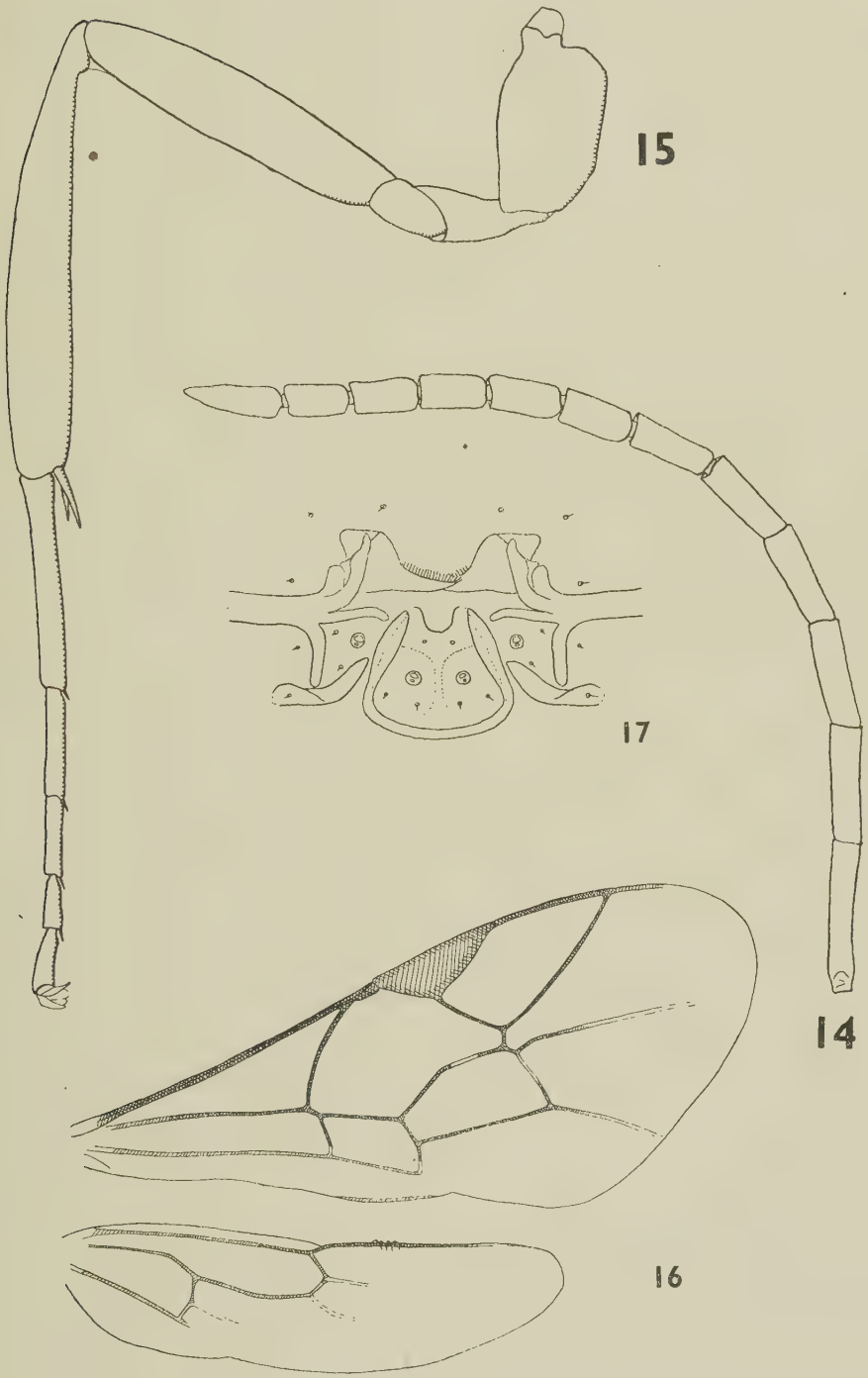
Length: 4–5 mm.

♂. As in the female, but much more slender; the 2nd tergite is evenly pubescent, the antennal segments less elongate, the yellow and testaceous markings less conspicuous.

Type. ♀, Sweden: Skåne, Skäralid, 3.vii.1938 (*D. M. S.* and *J. F. Perkins*).

Allotype. ♂, Sweden: Skåne, Höör district, 16.vi.1938 (*D.M.S.P.* and *J.F.P.*).

Co-types. Sweden: Skåne, Höör district, 1 ♀, 16.vi.1938 (*D.M.S.P.* and *J.F.P.*).



FIGS. 14–17.—*Adelognathus granulatus* sp. n. ♀: 14, flagellum; 15, hind leg; 16, wings; 17, facial rods and mouth-parts of final-instar larva.

England :—Hertfordshire : Harpenden, 4 ♂♂, 3 ♀♀, ix.1927 (ex *Pristiphora pallipes* Lep.) (*H. W. Miles*); Cheshire : Chester, 1 ♀, 13.ix.1929 (ex *Pristiphora pallipes* Lep.) (*H.W.M.*).

Ireland :—Co. Dublin : Monkstown, 1 ♀, bred from sawfly larva No. 34 (*G. E. Scott*).

The type and allotype are in the British Museum (Natural History).

I am indebted to Mr. B. P. Beirne for the figure of the facial rods and mouth-parts of the final-instar larva (fig. 17).

I have two females which I believe to be a variety of the above species, from Sweden, Skåne, Degaberga, 8 and 11.vii.1938 (*D.M.S.P.* and *J.F.P.*), in which the cheeks are entirely black and the prosternum is only yellow marked apically. I find no other difference between these and the typical form.

Adelognathus (*Notomeris*) *thomsoni* Schmied.

1888. *Adelognathus difformis* Holmgren, Thomson *nec* Holmgren, Thomson, *Opusc. Entom.* **12** : 1278.
1911. *Adelognathus thomsoni* Schmiedeknecht, *Opusc. Ichn.* **4** : 2159.
1918. *Adelognathus thomsoni* Schmied., Roman, *Ark. Zool. Stockholm.* **12** (2) : 14.

♀. *Head.* The temples parallel directly behind the eyes : the genal sulcus absent : clypeus strongly convex, coriaceous and dull; transverse : antennae long, 15-segmented, slightly thickened apically, with the penultimate segment about twice as long as broad : the genal carina inflexed; the occipital carina complete, angled centrally towards the ocelli : face, and the cheeks in part, coriaceous; the epistoma raised, the clypeus divided from the face : the temples and vertex polished, the frons finely coriaceous.

Thorax. Pronotum with the oblique lateral depression transcostate, the area before this striate, the striae more or less parallel with the anterior margin, the area between the depression and the posterior margin somewhat striate : mesonotum with the notauli distinct, extending to the middle of the mesonotum; shining, irregularly, weakly, finely sculptured anteriorly, evenly pubescent : mesopleurum shining, with sparse shallow punctures dorsad : the mesosternum with vague, irregular punctures : the sternauli weakly indicated anteriorly; mesolcus strongly impressed, deeper posteriorly, closed; epicnemia strong : scutellum polished, closely pubescent laterally, sparsely pubescent centrally : propodeum dull, in large part granulate; the basal area and areola confluent, the lateral carina strong, the petiolar area less clearly defined laterally; metapleurum dull, finely and closely granulate.

Legs. Hind tibia distinctly though not very strongly inflated, quite sharply constricted towards the base; the hind tarsus distinctly longer than the hind tibia, with the 2nd segment longer than the 5th.

Wings. The 2nd transverse cubitus present but not pigmented; the 2nd recurrent nerve received a little beyond the middle of the 2nd cubital cell.

Abdomen. Shining : the 2nd tergite with deep, oblique, basal furrows, with rather sparse pubescence laterally and apically and towards the base; the 1st tergite long, widening gradually to the slightly elongate post-petiole, with two distinct dorsal carinae; post-petiole irregularly, longitudinally striate; petiole in part dull.

Colour. Black : the following are pale yellow :—the scape, pedicel and 1st flagellar segment (also sometimes the 2nd at the base), the palpi, the mandibles sometimes in part, the extreme hind angles of the pronotum and the tegula; the 1st tergite is sometimes narrowly testaceous apically, the 2nd with a distinct, pale, testaceous apex, the 3rd with a broad, central longitudinal band, and the apex testaceous; the remaining tergites testaceous; the epipleura and sternites pale testaceous : the legs pale testaceous, marked paler and darker, with the apical tarsal segment at least in part infuscate.

Length : 5 mm.

Locality. Hertfordshire : Gade Valley, 2 ♀♀, 27.v.1934 (*R. B. Benson*).

Adelognathus (*Pammicra*) *dorsalis* (Grav.).

1829. *Hemiteles dorsalis* Gravenhorst, *Ich. Eur.* **2** : 266.
1883. *Adelognathus dorsalis* (Grav.), Thomson, *Opusc. Entom.* **9** : 880.
1888. *Adelognathus dorsalis* (Grav.), Thomson, *Opusc. Entom.* **12** : 1278.
1909. *Adelognathus dorsalis* (Grav.), Morley, *Brit. Ichn.* **4** : 318.
1911. *Adelognathus dorsalis* (Grav.), Schmiedeknecht, *Opusc. Ichn.* **4** : 2158.
1918. *Adelognathus dorsalis* (Grav.), Roman, *Ark. Zool. Stockholm.* **12** (2) : 15.

♀. *Head.* The temples narrowing a little directly behind the eyes : the genal sulcus absent : clypeus weakly convex, shining, not strongly transverse : antennae rather long, apically fusiform, the penultimate segment about twice as long as broad : the genal carina narrowly inflexed; the occipital carina complete, centrally not angled towards the ocelli : face and cheeks in part coriaceous; the epistoma quite strongly raised; the clypeus distinctly divided from the face : the temples and frons strongly shining, the frons coriaceous laterally towards the base of the antennae.

Thorax. Pronotum with the oblique lateral depression transcostate, the area before this polished, the area behind it with feeble, irregular punctures : mesonotum with the notauli distinctly impressed to about $\frac{1}{3}$ the length of the mesonotum; strongly shining, with distinct sculpture towards the anterior margin; the disc and an area extending back from this to the prescutellar fovea, glabrous : mesopleurum shining in part, sometimes weakly, irregularly sculptured or punctured, the punctiform fovea rather deep : mesosternum with sparse, shallow, irregular punctures, the sternauli distinct anteriorly; mesolcus very strongly impressed, deeper posteriorly, strongly closed behind; epicnemia very strong : scutellum polished with the disc glabrous, laterally and apically with long pubescence : propodeum with the basal area and the areola fused, narrow, with strong lateral carinae, weakly separated from the otherwise very distinct petiolar area; polished above, weakly, irregularly transcostate between the carinae; area postero externa complete : metapleurum in part granulate.

Legs. Hind tibia weakly inflated, not sharply constricted towards the base; the hind tarsus distinctly longer than the hind tibia, with the 2nd segment distinctly longer than the 5th : hind femora with a dorso-lateral sensory depression at the apical $\frac{1}{5}$, causing, when the femur is viewed laterally, a conspicuous constriction before the apex.

Wings. The 2nd transverse cubitus absent.

Abdomen. Polished : the 1st tergite with two dorsal keels extending almost to the apex, irregularly, longitudinally striate; the 2nd tergite with strong, deep basal furrows, with sparse pubescence laterally, apically and towards the base.

Colour. Black : the following are yellow :—the epistoma, clypeus, the mandibles centrally, the palpi, the scape at least ventrally, the flagellum ventrally, the extreme hind angle of the pronotum, the tegula; the 1st tergite sometimes very narrowly testaceous apically, the 2nd with a large triangular testaceous mark extending almost to the base, the remaining tergites with a broad testaceous longitudinal band; the epipleura yellow; the sternites yellow, with the apical sternite sometimes marked with fuscous or entirely black : legs paler and darker testaceous, the hind coxae black basally, the apical tarsal segments of all the legs usually, at least in part, infuscate.

Length : 5–7 mm.

Although I have examined a long European series of this very distinct species, I have yet seen no British specimens of it. Morley has recorded it from Surrey, Shere (*Capron*); Hants, New Forest; and Suffolk, Covehithe Broad (*Morley*). A figure of the male by R. Stenton is in Morley's *British Ichneumons* **4** : 318.

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5. Index.

(Sub-genera are given in brackets after the specific name. Synonyms are in italics.)

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REVISIONAL NOTES ON THE GENUS *DANAUS* KLUK (LEP. RHOP. DANAIDAE)

By G. Talbot, F.R.E.S.

Manuscript received 3 February, 1941.

(Read 4 November, 1942.)

With 9 Text-figures.

The extensive material of *Danaus*, now arranged in the British Museum, throws additional light on the affinities and synonymy of many forms. A number of new forms are described, and a list of these is appended. Localities of specimens in the Museum are cited; in many cases this extends our knowledge of the distribution. The genus is divided into 11 groups, with a total of 44 species. Forbes (1939) divides *Danaus* into 4 groups or subgenera.

I consider it more useful to divide a genus into as many groups or species-complexes as appear actually to exist, just as a species is to be resolved into its subspecies and minor forms. Such a system of analysis illustrates the essential characters of a species or genus as so far understood. The great dissector in this way was undoubtedly Moore, but we may disregard many of the names he used, since nomenclature is subordinate to taxonomy.

Abbreviations Used.

Fw.—Fore-wing.
Hw.—Hind-wing.
Ups.—Upperside.
Uns.—Underside.
Gr.-col.—Ground-colour.
P.-d.—Post-discal.
S.-m.—Submarginal.
Dc.—Discocellular.
Udc.—Upper discocellular.
Mdc.—Middle discocellular.
Ldc.—Lower discocellular.
Nom.—Nominotypical.

I am indebted to the Trustees of the British Museum for facilities in carrying out this work.

The use of the name *plexippus* Linn.

Owing to the controversy which has surrounded the use of the name *plexippus* Linn. it is necessary to explain why this name is here considered to represent an insect of the Oriental Region.

I have made some enquiry into the circumstances surrounding the use of the name *plexippus*, both as an American insect and as an Oriental one. The Linnaean description (1758, *Syst. Nat.* : 471) appears to me to leave no room for doubt as to the insect to which the name should be applied. Two possible species are indicated, but only one is defined by the statement that the fore-wing bears a subapical white band. "*Alae primores fascia alba, ut in sequente, cui similis.*"

The figures cited by Linnaeus are of American insects. They have not a band on the fore-wing similar to that of *chrysippus*, the species next described by Linnaeus on page 471. It is true, also, that North America is given as the locality.

By reference to earlier editions of the *Systema*, it is evident that prior to 1758 Linnaeus had only the American insect in mind, but when the description of 1758 was written he must have had either both the American insect and the Oriental species before him for the purpose of the description, or, since no figure of the Oriental species is cited in his description, only the latter.

It has been shown by Corbet (1941, *Proc. R. ent. Soc. Lond.* (B) **10** : 18, 27) as highly probable that the insects figured in Clerck's *Icones*, pt. i and Suppl., were from Linnaeus' own collection, and that these figures can be regarded as types. The specimen so figured under the name of *plexippus* represents the Oriental species and probably came from South-east China.

On the other hand Riley, 1928 (*Trans. ent. Soc. Lond.* **76** : 454), has given reasons, based on a specimen in the Linnaean Collection in the possession of the Linnean Society, for considering *plexippus* as being the American insect.

Fabricius, who was much associated with Linnaeus, obviously believed the Oriental insect to be *plexippus* (Linn.), and gave the American one the name *archippus*. The converse opinion was held by Cramer, who named the Oriental species *genutia*.

If one examines the books written by reputable authors in systematic and faunistic work, it will be found that of those who recorded the Oriental species a large majority used the name *plexippus* (Linn.), whilst most of those who recorded the American insect did not use *plexippus* (Cram.) but *archippus* (Fabr.); a few used *menippe* (Hübn.).

1. Authors using *plexippus* (Linn.) for the Oriental species.—Latreille, Hübner, Godart, Doubleday, Boisduval, Horsfield & Moore, Butler, Kirby, Aurivillius, Staudinger, Semper, de Nicéville, Bingham, Kershaw, Lefroy, Fruhstorfer, Waterhouse & Lyell, van Eecke, Moulton, Evans, Hulstaert, Roepke, Bryk.

2. Authors using *plexippus* (Cram.) for the American species.—Eschscholtz, Scudder, Strecker, Godman & Salvin, Moore, Grote, Ribbe, Seitz, Jordan, Riley.

3. Authors using *plexippus* for both species.—Holland, Pagenstecher. Both afterwards used the name for the American species only.

4. Authors using *archippus* for the American species, thus implying that *plexippus* was the Oriental one.—Smith & Abbott, Boisduval & Le Conte, Doubleday, Butler, Herrich-Schaeffer, Semper, Edwards, Distant, Dewitz, Weymer, de Nicéville, Kershaw, Haensch, Rebel, Fruhstorfer, Waterhouse & Lyell, van Eecke, Barnes & McDunnough, Aurivillius, Moulton, Comstock, Tillyard, Hulstaert, Roepke, Bryk.

5. Authors using *genutia* and so implying that *plexippus* (Linn.) was not the name for the Oriental species.—Hübner (later used *plexippus*), Distant, Moore, Marshall & de Nicéville (later used *plexippus*), Doherty, Elwes, Holland, Seitz, Corbet & Pendlebury (admittedly followed Riley, 1928, in this respect).

It will be seen that 23 authors used *plexippus* (Linn.) for the Oriental species, and 10 for the American one; 25 authors used *archippus* for the American species.

The argument in favour of *plexippus* (Linn.) being the Oriental species was strongly developed by F. J. Buckell in 1894 (*Ent. Rec.* **5** : 1–5). In the same year Kirby similarly decided (Allen's *Nat. Libr. Lep.* **1** : 19, pl. v, fig. 1). The point was again stressed by de Nicéville in 1895 (*J. Asiat. Soc. Bengal*, **64** : 368).

Genus *Danaus* Kluk.

Erippus Group (*Anosia* Hübn., 1816; *Tasitia* Moore, 1883).

Danaus menippe (Hübner), 1816 (= *archippus* Fabr., 1793, *non* Cramer, 1775 (= *Limenitis*)); *plexippus* Cram., 1779, *non* Linn., 1758; *curassavicae* Bryk, 1937).

In Bryk, 1937 : 42, the name *curassavicae* Fabricius is used as being the earliest name for the species. The reference "*Syst. Gloss.* **1807 : 69**" is to the unpublished manuscript of this work which was published by Bryk in facsimile in 1938. The name *curassavicae* was, therefore, first published in 1937 and becomes a synonym of *archippus* and *menippe*.

In 1845 appeared an autobiography of Fabricius translated by the Rev. F. W. Hope (*Trans. ent. Soc. Lond.* **4** : i–xvi). This records every work on Lepidoptera known to have been published by Fabricius, but no mention is made of the *Systema Glossatarum*. Griffin (1939) (*Journ. Soc. Bibl. nat. Hist.* **1** (9) : 261–267) shows that the *Syst. Gloss.* was not previously published except in part by Illiger (*Illiger's Mag.* **6**, 1807). The date of the *Syst. Gloss.* is 1938.

ssp. *menippe* (Hübn.).

Fw. subapical spots usually yellow; subapical area brown.

form *fumosus* (Hulst), 1886 (= *americanus* Gunder, 1927).

Fw. more or less darkened.

form *leucogyne* (Butler), 1884 (= *nivosus* Gunder, 1927).

Both wings with brown areas more or less white.

Hab.—A long series of both sexes from Canada, U.S.A., Central America, Cuba, Bahamas, Azores, Canary Is., China, Formosa, Philippines, Talaut Is., Dammer, Moluccas, Schouten Is., Mefor I., New Guinea to Solomons and other Pacific Islands.

Form *leucogyne* is represented by 1 ♂, 2 ♀ from Amboina, and 1 ♀ from Ceram; 1 ♂ from Fiji is transitional, the brown areas of upperside being very pale coffee-brown.

ssp. *nigrippus* (Haensch), 1909, Nicaragua.

Fw. subapical spots white; apical area black, or with only traces of brown.

Hab.—A series of both sexes from Nicaragua, Venezuela, Colombia, Peru, Ecuador, Guiana, and Amazon; Galapagos Is., 1 ♂.

Most females from Colombia and Peru are of the form *fumosus* (Hulst). The form *leucogyne* is represented by a ♂ without locality.

ssp. *megalippe* (Hübner), 1826.

Fw. subapical spots usually white; apical area with brown markings.

Hab.—A series of both sexes from Jamaica, St. Lucia, Dominica, St. Vincent, St. Martins, St. Kitts and Nevis, Montserrat, Tobago, Barbados, Cayman, Trinidad, Martinique, St. Thomas, and Haiti.

The form *leucogyne* is represented by 1 ♀ from St. Kitts, and type ♀ from St. Thomas.

Danaus erippus (Cramer), 1775.

The nom. form has fw. subapical spots white. There is also a form with yellow spots. The form *larensis* (Kohler, 1929) has ups. more or less suffused with black.

Hab.—A series of both sexes from Argentine, Paraguay, Uruguay, Bolivia, Chili, Matto Grosso, and from South Brazil to Para.

Danaus cleophile (Godart), 1819.

Hab.—A small series from Haiti and S. Domingo. Also Jamaica: Moneaque (ex Coll. Godman & Salvin); "Jamaica" (ex Coll. Gosse).

Danaus gilippus (Cramer), 1775.

ssp. *berenice* (Cramer), 1779.

form *thersippus* (Bates), 1863.

Both sides paler than in *berenice*, and submarginal spots on uns. tend to be larger.

form *strigosa* (Bates), 1864.

Hw. ups. with white vein-streaks beyond the cell; colour of both wings as in *thersippus* or *berenice*.

Form *kerri* (Comstock), 1925, California.

Ups. more prominently spotted. Doubtfully distinct from many *thersippus*.

Hab.—A series of both sexes from Central America and Southern States to California; Cuba, Bahamas, Cayman. Most specimens from C. America are of the form *strigosa*, and are mostly paler than Florida specimens which belong to the dark *berenice* form.

The type ♀ of *strigosa* from Guatemala, and the type ♂ of *thersippus* from Lion Hill, Panama, are in the British Museum.

ssp. *jamaicensis* (Bates), 1864.

A very pale race.

Hab.—Jamaica, a series of both sexes.

ssp. *cleothera* (Godart), 1819 (= *kaempfferi* Hall, 1925).

Danaus gilippus cleothera Forbes, 1939 : 134.

Hab.—Haiti and S. Domingo.

The identity of this insect with *kaempfferi* Hall, has been established by Forbes, *op. cit.*

ssp. *xanthippus* (Felder), 1860, "Brazil" (= *centralis* Joicey & Talbot, 1925, Venezuela).

Felder, in his original description of this insect, says that the abdomen has a white ventral stripe. This character is peculiar to *gilippus* and does not exist in *eresimus*. Correctly placed by Forbes (1939) under *gilippus* with *centralis* as a synonym.

Hab.—Venezuela (San Esteban and Caracas), a series of both sexes; Colombia (Magdalena), 1 ♀; "Interior of Colombia," 1 ♀; Trinidad, 3 ♂. The types of *centralis* are included.

ssp. *hermippus* (C. & R. Felder), 1865.

Hab.—Colombia, a series of both sexes from Rio Dagua, Cauca, Antioquia, Honda, Villavicencio; Venezuela (Merida).

The Merida specimens are transitional between *xanthippus* and *hermippus*. Ups. somewhat paler brown, and dusted with white more especially on fw. discal area.

ssp. **wheeleri** ssp. n.

♀. Ups. colouring as in *xanthippus*, and black outer borders of both wings broader. Fw. with the three p.-d. spots placed close to the black border, the spot in area 2 touching the edge of border. Uns. similar to *xanthippus* but with wider borders. Fw. spots as above; apical area blackish. Abdomen without a white ventral line as in *eresimus*.

Hab.—" Interior of Colombia (*Wheeler*)," 2 ♀ ex Coll. Godman & Salvin.

This insect does not appear to agree with either *eresimus* or *gilippus*. Its position here is provisional, and the discovery of a male should establish its true affinity.

ssp. *nivosus* (Godman & Salvin), 1897.

Hab.—North Peru and South Ecuador (Loja), a series of both sexes with types.

ssp. *gilippus* (Cramer), 1775.

Hab.—Para to Paraguay and Matto Grosso; a series of both sexes covering Brazil and Paraguay. Also Argentine, Bolivia (Cochabamba).

Danaus plexaure (Godart), 1819, Brazil.

The distribution of this insect seems to indicate it as being a subspecies of *gilippus*. According to material in the British Museum, both insects occur together at Chapada in Matto Grosso, but there is only one *plexaure* to five *gilippus*, the latter also from other parts of Matto Grosso.

Hab.—Argentine, Paraguay, Brazil.

Danaus eresimus (Cramer), 1777, Guiana.

This species has, on hw. uns., a p.-d. row of faint spots, slightly paler than the dominant wing-colour. Abdomen without a ventral white stripe.

ssp. *eresimus* (Cramer).

Hab.—A series of both sexes from Jamaica (1 ♂), Haiti, Grenada, Guiana, Amazon (Ucayali, S. Paulo, Iquitos, Pebas, Ega).

The Jamaican ♂ is much lighter than any of the others.

ssp. *dilucida* Forbes, 1939, Santarem.

Both wings with much reduced black areas. Hw. marginal black border absent or but slightly developed.

Hab.—Amazon (Santarem, Serpa, one from Ega).

ssp. **estevana** ssp. n.

Fw. with white spot in area 2 vestigial on both sides.

Hab.—Venezuela, San Estevan, near Puerto Cabello (*Hahnel de Sagan*), Jan.–March 1877, 5 ♂ (type); " San Esteban " (ex Stgr.), 1 ♂; S. Fernando

Apure (*L. Laglaize*, 1896), 4 ♂; Caracas (*Maj. A. Pamm*), 1 ♂; Imataca, 1 ♂ (spot entirely absent, and spot in 3 vestigial); Macuto, 400 feet, 10.iii.22 (*F. W. Jackson*), 1 ♀; Bergantin, 9.v.1926 (*J. P. de Verteuil*), 1 ♀ (allotype); "Venezuela," 1 ♀. COLOMBIA: Rio Magdalena, 8.ix.1877 (*Dr. O. Thieme*), 1 ♂; Magdalena Valley, El Banco (*C. Allen*), 1 ♂; Manaure, N. Colombia (*F. Simons*), 1 ♂; Sta. Marta, 1 ♂; Colon, Panama (*A. Boucard*), 1 ♂; Santa-Fé de Bogota, 1 ♂; "Interior of Colombia" (*Wheeler*), 1 ♂, 1 ♀; "Bogota," 1 ♀.

This insect occurs as a form with the nom. subsp.

ssp. *erginus* (Godman & Salvin), 1897.

Hab.—North-west Peru (Vina) (types and paratypes), North Peru (western slopes of Andes), Ecuador (Quevado), "Brazil."

ssp. **montezuma** ssp. n. (= *cleothera* auct. *non* Godart).

This form has usually been thought to represent *cleothera* (Godt.), and has also been confused with *xanthippus* (Feld.).

♂♀. Ups. with white spots small. Fw. rarely with spots in areas 2 and 3, either above or below; black area extending into upper part of cell and rarely beyond the cell.

Hab.—Mexico, Guatemala, Costa Rica, Salvador, Nicaragua, Honduras, 35 ♂, 15 ♀. Type ♂, Mexico: Misantha, Veragua (*W. Gugelmann*). Allotype ♀, Mexico: Cordoba region (*L. Conradt*, 1901–3).

A specimen from Panama, in Coll. Cornell University, is recorded by Forbes (1939).

Chrysippus Group.

(*Limnas* Hübner; *Panlymnas* Bryk).

Danaus chrysippus (Linnaeus), 1758.

The nom. form of this insect came from China (Corbet, 1940). Seven subspecies may be distinguished. In the Aethiopian Region there is a narrow-banded race, a broad-banded race, and one with hw. largely white. These races occur as individual forms.

ssp. *aegyptius* (Schreber), 1759, Egypt (= *klugii* Butler).

Papilio aegyptius Schreber, 1759, *Novae Species Insectorum*: 12, pl., figs. 11 (♀ upperside), 12 (♀ underside).

Fw. with a narrower band; in typical examples the posterior spot of the band touches the spot above it. Specimens also occur with the posterior spot quite separated from the band. Ups. coloration darker than in the nom. form.

Hab.—Eastern Mediterranean, and whole of Africa except western zone.

Three main forms are distinguished. These, with their minor forms, are as follow.—(1) *aegyptius* (Schreber), with f. *liboria* (Hulstaert); (2) *alcippus* (Cramer), with *alcippoides* Moore, 1883; (3) *dorippus* (Klug, 1845), with *albinus* (Lanz, 1896), *transiens* (Suffert, 1900), and *semialbinus* (Strand, 1910).

The form *aegyptius* is dominant in the eastern Mediterranean and Egypt, also over southern Africa to Nyasaland, Rhodesia, and the Congo, in the latter area being mixed with a large proportion of *alcippus*.

The form *alcippus*, constituting the western subspecies, is dominant in the Sudan.

The form *dorippus* appears dominant in Abyssinia, Somaliland, Kenya and Tanganyika Territory; it may be considered almost as an eastern race.

In Uganda the three forms appear in nearly equal numbers.

ssp. *alcippus* (Cramer), 1777.

This race is distributed over the West African zone from the South-west Sudan to the Cameroons. The forms *alcippoides* and *aegyptius* occur rarely.

ssp. *liboria* (Hulstaert), 1931 (= *orientis* Aurivillius, *non* Doherty).

The Malagassic race, occurring on Mauritius, Bourbon, Rodriguez, Nossé-Bé, Seychelles, Comoros, Madagascar.

The forms *dorippus* and *alcippoides* are very rare.

ssp. *chrysippus* (Linn.), 1758.

The British Museum contains specimens from the following areas:— Socotra, with forms *dorippus* and *albinus*; Arabia, with forms *dorippus*, *transiens*, *alcippoides* and *albinus*; Transjordan; Mesopotamia, with f. *alcippoides*; Persia, with f. *alcippoides*; Transcaspia; Turkestan; Afghanistan, with f. *alcippoides*; Baluchistan; Chitral, with f. *alcippoides*; North-West India, with f. *alcippoides* and f. *transiens*, also two very pale whitish males from Waziristan, and a similar ♂ from Ambala, Punjab; Peninsular India, with f. *alcippoides*, f. *transiens*, and f. *dorippus*; Central India to Bengal, Sikkim, Assam, Burma, Yunnan, Andamans and Ceylon; a ♂ of *alcippoides* from Assam, and specimens of *bowringi* from Burma and Yunnan; China, Japan, Formosa, Hainan, Ishigaki Islands, Tonkin, Siam, Indo-China; specimens of *bowringi* from China, including ♀ holotype; Malaya, including f. *margarita* and f. *alcippoides*; Sumatra and Nias, including f. *bataviana* and f. *alcippoides*; Borneo; Sulu; Palawan; Philippines, including f. *bowringi*.

The following forms of *chrysippus chrysippus* have been described:—

form *bowringi* (Moore), 1883, Hong Kong.

Fw. with a white spot in area 2, at least on ups.

form *margarita* (Röber), 1926, Malaya.

Founded upon a very small dark specimen.

form *limbata* (Matsumura), 1929, Formosa.

Hw. with a proximal dark brown border to the outer black border.

form *subpurpurea* (Matsumura), 1929, Formosa.

A *dorippus* form, but whitish. Fw. costa not darkened. Both wings with prominent marginal white spots.

form *rubra* (van Eecke), 1915, Pulau Weh.

Fw. reddish-brown. Hw. as in *alcippoides*.

form *auriflava* (van Eecke), 1915, Simalur.

Ups. light brown. Fw. with very large white spots beyond cell.

form *clarippus* (Weymer), 1884, Nias.

Described from 1 ♂, 2 ♀, out of about 500 of the typical form.

An aberration with extensive white markings: fw. cell white, band very broad, spots large; hw. uns. with white streaks.

To these an eighth form must now be added.

form **amplifascia** f. n.

♂♀. Fw. with white band extended proximally; spots in areas 4 to 6 longer; spots at bases of 4 and 5 larger, especially the one in 4; p.-d. spot in 3 usually larger; costal spots usually larger, and merged in a white costal stripe.

In a Tonkin ♂ the lower spot of the band, in area 3, is joined to the spot in 4, and is almost separated from the band, the spot in 4 being much smaller than is normal; costal spots normal.

An extreme development occurs in a ♂ which is without locality. Spots in areas 4 to 6 reach almost to cell, and include the small post-cellular spots, forming a broad white patch; spot in 3 minute; costal white streak present.

Material examined in B.M.—India: Poona, ix.1887 (ex Coll. Swinhoe) (type ♀, figured in *Lep. Ind.*, pl. 8, fig. 1*e*); Campbellpore, xi.1885, 1 ♀; Hong Kong, 18.iii.1892, 1 ♂; Hong Kong, 1 ♂; Tonkin (ex Coll. Buckland), 1 ♂; no loc., 1 ♀.

ssp. *bataviana* (Moore), 1883 (= *vigelii* Heylaerts, 1884).

In the British Museum from Java, Kangean, Bali, Lombok, Sumbawa, Sumba, Kalao, Billiton, Bawean, Saleyer, Celebes, Talaut Is. The Celebes specimens include *gelderi* (Snellen, 1891).

form *pseudopetilea* (Kalis, 1933), Kangean.

A female aberration. Paler brown, with marginal borders wider. Hw. with s.-m. white spots.

ssp. *cratippus* (Felder), 1860, Amboina.

In the British Museum from Savu Is., Timor, Wetter, Roma, Letti, Kisser, Tenimber, Aru, Alor, Buru, Amboina, Ceram, Ternate, Halmaheira, Obi.

A pale and a dark form, the latter resembling *bataviana* but with wider marginal borders. Most Batjan specimens are of the dark form. There is a pair of f. *petilia* (Stoll) from Tenimber.

ssp. *petilia* (Stoll), 1790.

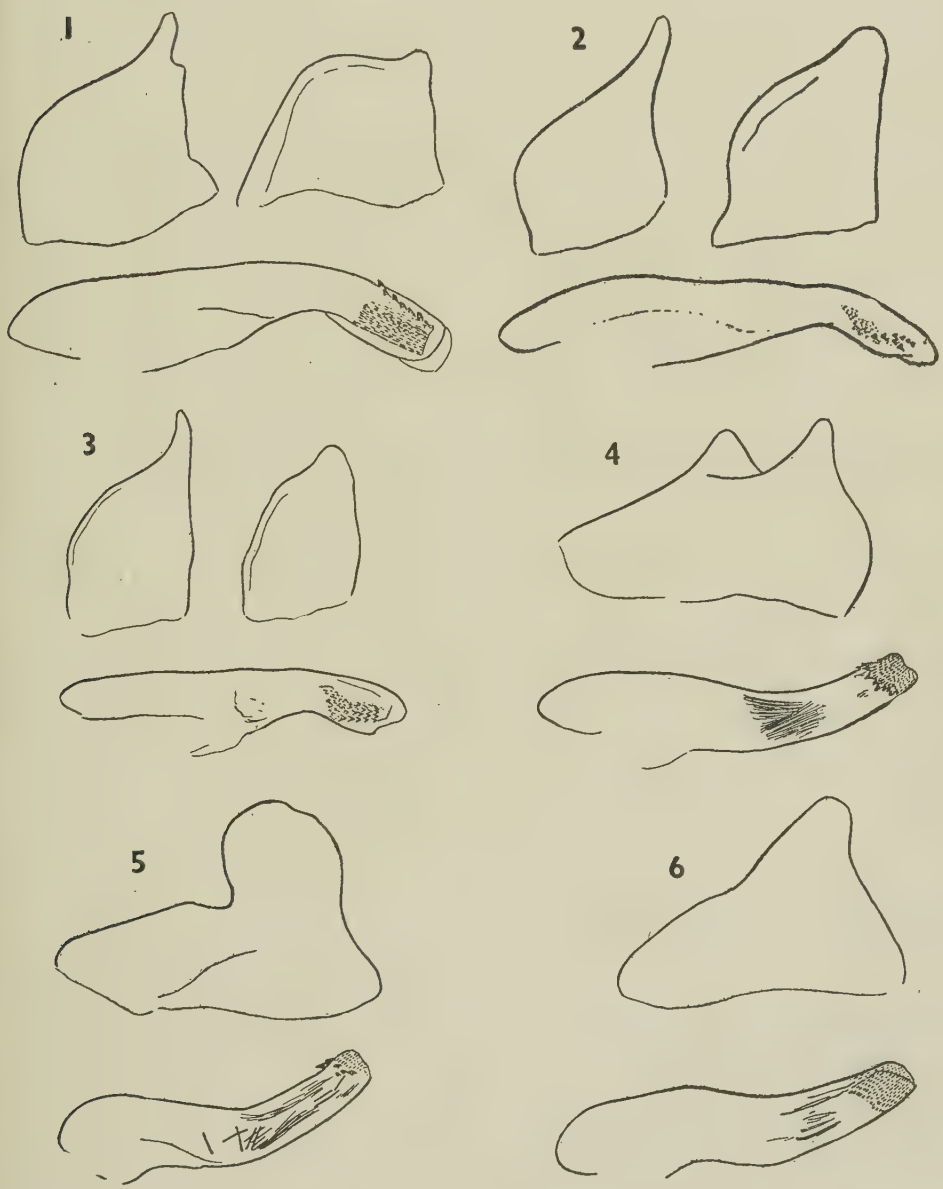
In the British Museum from Australia, Cocos Is., Monte Bello Is., Christmas I., Thursday I., New Hebrides, New Guinea (St. Aignan, Yule I., Huon Gulf). The Australian series, from all parts, is very constant in colouring. There is a ♀ *dorippus*, from Coll. Adams, labelled "Roebourne, N.W. Australia", in very fresh condition.

Genitalia and wing-structure in the Plexippus, Cleona and Melaneus Groups.

In order to ascertain the specific distinctness or otherwise of some forms, which have at times been treated as species and at other times as subspecies, a number of dissections of males were made.

1. Wing-structure.

Plexippus Group.—Hw. with vein 5 arising much nearer to 6 than to 4. Scent-patch small, oval, raised, forming a sort of flap, well developed on both sides of wing on the fold in area 1c.



(Each figure represents the valve and aedeagus.)

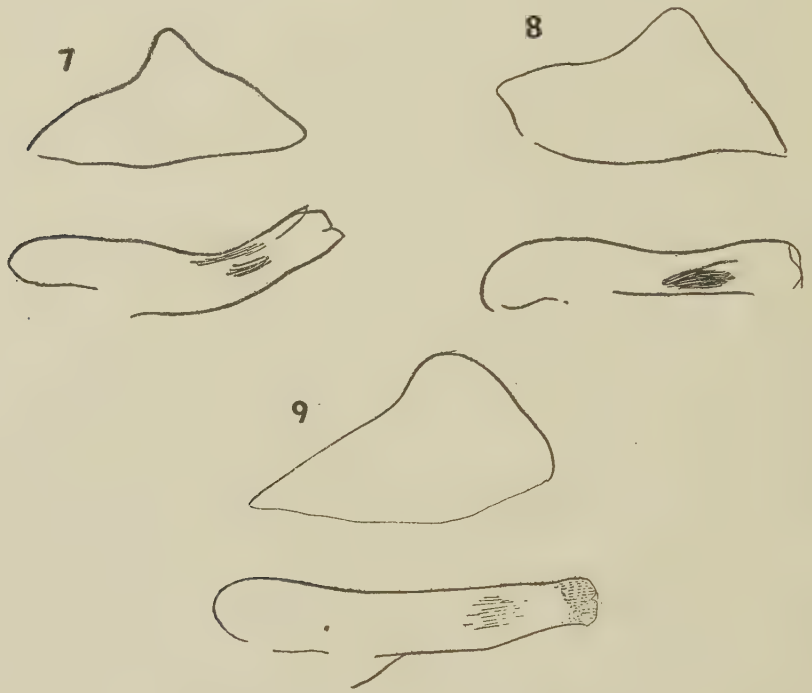
FIGS. 1–6.—1, *Danaus melanippus melanippus* (Cram.). West Java; 2, *Danaus affinis philene* (Cram.). Amboina; 3, *Danaus affinis affinis* (Fabr.). North Australia; 4, *Danaus aspasia aspasia* (Fabr.). Peninsular Siam; 5, *Danaus vitrina vitrina* (C. & R. Feld.). Luzon; 6, *Danaus cleona cleona* (Stoll). Amboina.

Cleona Group.—Hw. with vein 5 arising much nearer to 4 than to 6. Scent-patches comprising an area of modified scales placed near outer margin on either side of veins 1*b* and 2, the latter patch much larger; veins 1*a* and 1*b* not distally dilated.

Melaneus Group.—Hw. with vein 5 arising as in the Cleona Group. Scent-patches similar to those of Cleona Group, but in some species absent from area 2 and from anterior part of 1*c*. Vein 1*b* dilated within area of patch; similarly vein 1*a* is dilated in some species.

2. Genitalia.

Plexippus Group.—Valves asymmetrical, the right-hand one distally prolonged to a tapering finger-like shape. The other valve is usually broader and not much produced



(Each figure represents the valve and aedeagus.)

Fig. 7–9.—7, *Danaus melaneus melaneus* (Cram.). Western China; 8, *Danaus luzonensis luzonensis* (C. & R. Feld.). Bazilan; 9, *Danaus phyle* (C. & R. Feld.). Luzon.

distally, and in any case to a much less degree. In *philene* and *affinis* the right valve is narrower distally than in *melanippus*; in *haruhasa* this valve is of the *melanippus* type.

Aedeagus.—In *melanippus* there is a lateral row of strong, short, broad, somewhat triangular spines. In the nom. form five or six spines are present; in *edmondi* three spines were seen, also in *haruhasa* but smaller, one being minute.

Cleona Group.—Valve, except in *vitrina*, broadly triangular, distally shortly produced and rounded. In *aspasia* distally bipartite, there being a semi-circular excavation. In *cleona* and *schenkii* there is a lateral ridge from apex to base, this ridge clothed with rough hair; a similar ridge is seen in *aspasia*. In *vitrina* the distal part of the valve is expanded to a broad rounded lobe which is clothed with rough hair. In *cleona* and *schenkii* the valve has a similar shape, indicating, perhaps, that these two are more closely allied than the two other species are to each other.

Aedeagus.—A bundle of rod-like bodies (? spines or hairs) is attached to the vesica; the distal ends of these appear more pointed than the proximal ends, the whole forming a sort of close brush. This brush is of varying length and breadth. Distal end of aedeagus armed with spines. In *cleona* these spines are of irregular shape, mostly short, and moderately strong. In *aspasia* and *vitrina* the spines are mostly larger and stronger than in *cleona* and *schenkii*, and more distinctly triangular; in *vitrina* more numerous. In *schenkii* the spines are weaker and much smaller than in the other species mentioned.

Melaneus Group.—Valve similar to that of *cleona* and *schenkii*, and excepting *phyle* with no very marked difference between the species. In *phyle* the valve is not triangular but broadly spatulate. As in the preceding group, the valve consists of a double wall enclosing a cavity.

Aedeagus.—Resembles that of the Cleona Group but is not armed with spines. In *phyle* and *sita* no vestige of an internal brush was found (two *phyle* and one *tityoides* examined).

Conclusions.—The Plexippus Group is much more distinct from the Cleona and Melaneus Groups than are these from each other.

The insects represented by *philene* and *mytilene* are quite distinct from *melanippus*. In Bryk (1937) they are treated as subspecies of *melanippus*. The insects represented by *edmondi* and *haruhasa* belong to *melanippus*, and *affinis* and *philene* are conspecific.

The following appear to be distinct species:—*D. aspasia*, *vitrina*, *cleona*, *schenkii*, *taprobana*, *nilgiriensis*, *melaneus*, *luzonensis*, *phyle*, *albata*, *menadensis*, *sita*. *D. crowleyi* is referred to *melaneus*.

The specific distinctions between *melaneus* (Cram.) and *luzonensis* (Feld.) are obscure. Genitalia very similar. Some forms of *melaneus* much resemble *luzonensis* in wing-pattern, although where occurring together they are easily distinguished. Hw. of *luzonensis* with vein 1*a* dilated in anal area; this is not the case in nom. *melaneus* though it is in the Javan subspecies. A more certain distinction is found on the fw. This concerns the distance separating the stripe in area 5 from the inner s.-m. spot. In *luzonensis* this distance ranges from 3·5 mm. (rarely) to 6·5 mm. In *melaneus* the distance is from 1 mm. to 3 mm.

Plexippus Group.

(*Danaus* Kluk, *Danaida* Latr., *Salatura* Moore).

Danaus melanippus (Cramer), 1777, Java.

The forms usually included under *lotis* (Cramer, 1779), and *haruhasa* (Doherty, 1891) are here considered as belonging to *melanippus*.

ssp. *hegesippus* (Cramer), 1779, Sumatra.

Occurs also on Banka and Billiton. The form *indicus* (Fruhstorfer) is plentiful in Sumatra, and some specimens are transitional.

ssp. *lotina* (Fruhstorfer), 1904, Natuna Is.

Considered by Fruhstorfer to be a form of *lotis* (Cramer). Fw. spots and patches as in *nesippus* (Felder), but patches brown as in *hegesippus*. Hw. as in *hegesippus*, but the white stripes not dusky.

ssp. *thoë* (Hübner), 1816.

This name must replace *lotis* Cramer (1779), which is a homonym of *Papilio Nymph. Gemm. lotis* Sulzer, 1776 (*Gesch. Ins.* **1**: 144; *id.* **2**, pl. 16, fig. 6), " aus

Indien" (= *Cupha erymanthis* subsp.). The name *thoë* was introduced by Hübner to replace *lotis* Cram., but he gave no reason for his action.

ssp. *edwardsi* (v. Eecke), 1914, Simalur.

A very striking form. Fw. with additional white stripes in areas 2 and 3; a white spot in end of cell; brown patches vestigial.

ssp. *haruhasa* (Doherty), 1891, Sumbawa.

Also occurs in Flores, Lombok, Adonara, Pura, and Alor.

ssp. *edmondii* (Lesson), 1837, Philippines (= *philoxigetes* Fruhstorfer, 1907, Southern Philippines).

In the British Museum from Palawan, Mindanao, Bazilan, Mindoro, Central Philippines, Luzon; also 1 ♂ from Guam (ex. Coll. Wileman).

ssp. *celebensis* (Staudinger), 1889, N. Celebes.

The form *malosoma* (Fruhstorfer), 1899, described as a race of *melanippus*, is obviously a brown form of *celebensis*, judging by the ♀ holotype from N. Celebes.

Danaus plexippus (Linnaeus), 1758.

The use of this name has been discussed in the introduction.

ssp. *plexippus* (Linn.) (= *genutia* Cramer, 1779).

The subspecies ranges over the whole of India from Afghanistan east to Burma, Ceylon, the Andamans and Nicobars, Yunnan to China, the Riukiu Is., Formosa, Hainan, Tonkin, Annam, Siam and Indo-China.

The following forms are recognised :—form *nipalensis* (Moore), 1877, Nepal. form *grymion* (Fruhstorfer), 1910, Siam. form *connectens* (Moulton), 1921, Malaya (hw. with rudimentary white stripes).

form **albipars** f. n.

♂♀. Both wings, on both sides, with extensive white coloration. Fw. band very broad, extended proximad, the spot in area 3 also elongate; spots in 2 and 1*b* developed; other parts of wing more or less scaled white. Hw. mostly white, with traces of brown at least on inner area; s.-m. and antemarginal spots strongly developed, or entire marginal area white.

Material examined in British Museum.—Sikkim, 3.xii.1886 (*O. Möller*) (ex Coll. Leech), ♀ type; Burma, Pyinmana Distr., Karen Hills (*A. B. Freeman*), 1 ♂; without data, 1 ♀.

The last two specimens are very largely white, and hw. without dark border.

ssp. *uniens* (Martin), 1911, S. Sumatra.

Resembles *niasicus*, the white band narrower. A ♂ in the British Museum, from Kroë, has white suffusion on hw. in the post-cellular areas below vein 5.

ssp. *intensa* (Moore), 1883, Java.

Also in the British Museum from Bawean, Kangean, and Bali.

ssp. *bimana* (Martin), 1911, Sumbawa.

Also in the British Museum from Flores, Alor, and Lomblen.

ssp. **sumbana** ssp. n.

♂♀. Resembles *intensa* from Java, but ups. is paler brown, and white band broader.

Hab.—Sumba, 2 ♂, 1 ♀. The types are labelled " Doherty, 1887 ".

ssp. *bandjira* (Martin), 1911, Banjermassin.

Very similar to *intensa*, the spots composing the white band being slightly narrower.

Common in north and south Borneo.

ssp. *adnana* (Swinhoe), 1917, Luzon.

Resembles the nom. form, but smaller. Fw. with brown stripe in area 2 shorter, and usually absent from area 3.

In the British Museum from Luzon, Mindoro, and Samar.

ssp. *kyllene* (Fruhstorfer), 1910. Dammer.

Also in the British Museum from Kisser, Letti, Roma, Timor, and Key.

ssp. *alexis* (Waterhouse & Lyell), 1914, Port Darwin.

A small form. Fw. band compact and narrow; s.-m. spot in area 2 minute.

In the British Museum 1 ♂ from the Adelaide River, North Australia (*J. J. Walker*).

Danaus affinis (Fabr.), 1775.

As explained in the introduction to this group, this species is here considered as including *philene* (Stoll). Both forms may occur together but always with one much preponderating over the other, and in some cases with forms showing a mixed pattern. The lighter or *affinis* forms range from the Nicobars and Malaya to Australia and the Bismarck Islands. The darker or *philene* forms have a more restricted range from Celebes and Moluccas to Australia and Solomons.

(1) *philene* forms.

ssp. **fuscata** ssp. n.

♂. Much darker, and brown stripes shorter than in the nom. *philene*. Hw. uns. with s.-m. white dots smaller; discal white spots reduced to a dot in bases of areas 2, 3, and 4 at most, besides a small spot in end of cell.

Hab.—Bangka Island, north-east Celebes (*W. Doherty*), 2 ♂.

ssp. *obscura* (Capronnier), 1886, Waigeu.

Also in the British Museum, from Dutch West New Guinea (Fak Fak and Kapaur).

ssp. *subnigra* (Joicey & Talbot), 1922, Biak.

This commences a series of Papuan forms, all with very dark ups., the brown stripes vestigial or absent. Fw. subapical band in most forms composed of very small, separated,

white spots. The form *subnigra* resembles *mytilene* (Feld.), but is darker, with smaller spots.

Also in the British Museum from Mefor, including a ♂ with brown stripes strongly developed on both wings.

ssp. *jobiensis* (Grose-Smith), 1894, Jobi (= *pittakus* Fruhstorfer, 1906).

ssp. *mytilene* (Felder), 1860, Dorey (= *pullata* Butler, 1866, Dorey).

The range of this form extends over Dutch North-East New Guinea, including the region around Geelvink Bay.

form **signata** f. n.

♂. Ups. fw. with subapical band composed of separated stripes in areas 3 to 5, 6, 9, and 10, the one in 4 the longest and, with those in 3 and 5, larger than the others and slightly dusted with brown. A striking form.

Hab.—Mioswar Island, Geelvink Bay, ix–x.1909 (*C. & F. Pratt*), 1 ♂.

ssp. **sabrona** ssp. n.

♂♀. Resembles *bonguensis* (Fruhst.), but differs on fw. in having the spots forming subapical band larger.

Hab.—Dutch New Guinea: Cyclops Mountains, Sabron, 1200 feet, May 1936 (*L. E. Cheesman*), 2 ♂ (type); *id.*, 930 feet, July 1936, 1 ♂ (wings with more red-brown colouring); coast between Geelvink and Humboldt Bays, October to December 1896 (*W. Doherty*), 9 ♂, 12 ♀ (♀ allotype); Humboldt Bay, September and October 1892 (*W. Doherty*), 1 ♂.

ssp. *bonguensis* (Fruhstorfer), 1899, Bongu.

Ups. with the brown stripes much paler than in other Papuan forms of *philene*.

Hab.—Mandated New Guinea; Vulcan and Dampier Islands.

ssp. *pleistarchus* (Fruhstorfer), 1912, Matty Island (north Mandated New Guinea).

Resembles *ferruginea*, but band in fw. broader.

ssp. *ferruginea* (Butler), 1876, Port Moresby (= *molyssa* Fruhst., 1906, Collingwood Bay).

Ups. colouring as in *mytilene*. Fw. with a compact band of larger spots.

Hab.—British New Guinea, including Yule Island.

form **oesypera** f. n.

Presents a mixture of *philene* and *affinis*, and is placed under *ferruginea* on account of gr.-col., and the scarcely perceptible androconial streaks on hw.

♂. Fw. with subapical spot in area 4 smaller, and placed more distad; discal spot in area 2 white tinged with brown; below vein 2 an indistinct whitish narrow streak. Hw. with discal diffuse dusky white spots, one in the cell, and others in bases of areas 2–5. Uns. fw. without discal white markings. Hw. discal spots more defined and white.

Hab.—British New Guinea: "Port Moresby and Yule Island," dry belt, sea level (*J. P. de Verteuil*), 1 ♂. The abdomen of this specimen is missing.

ssp. *biseriata* (Butler), 1882, Duke of York I.

Fw. subapical band absent or reduced to three or four white dots. Hw. s.-m. spots well developed.

Also in the British Museum from New Britain and New Ireland.
A ♀ from Santa Cruz may belong here :—

Fw. with five subapical, rather small, white spots, the anterior three reduced to dots. Hw. with complete rows of s.-m. and antemarginal dots.

ssp. *decipiens* (Butler), 1882, " Solomons ".

Ups. with red-brown stripes more prominent; subapical band of usually three dots. Hw. usually with small discal white spots.

In the British Museum from Guadalcanar, Fauro, Rendova, Florida, Renonga, Savu, Ulawa, Alu, Shortland, Choiseul, Villa Lavella, New Georgia, Bougainville.

ssp. *decipientis* (Strand), 1914, Admiralty Islands.

A small dark form. Fw. with five or six subapical small spots. Hw. with discal white spots.

(2) *affinis* forms.

ssp. *affinis* (Fabricius), 1775 (= *nigrita* Moore, 1883).

White markings fully developed, no brown colouring.

Hab.—Australia. In the British Museum a series of both sexes, including ♂ type, from Queensland, North and North-West Australia; also Richmond River, N.S.W. (*G. A. Waterhouse*), 1 ♂.

ssp. **albistriga** ssp. n.

♂♀. Ups. with white markings much as in the nom. form. Fw. with posterior stripe touched with brown at distal end; cell with a short white streak; subapical spots usually narrower; a second subapical white dot as in *cometho*, but placed nearer the apical one. Hw. with more or less distinct, narrower, red-brown stripes in distal area; s.-m. white dots well developed. Uns. fw. with cell-streak more prominent.

Hab.—Loyalty Islands, Lifu, ♂♀ (♂ type); Loyalty Islands, 1 ♀ (allotype); Uvea, 1 ♂; New Hebrides, 2 ♂, 1 ♀. Also 1 ♂ labelled " Malbieto " (?) (ex Coll. Grose-Smith); in this latter and a ♂ from New Hebrides the cell-streak is vestigial.

ssp. **bipuncta** ssp. n.

♂. Ups. fw. with subapical spots larger than in most specimens of the nom. form, especially the spot in area 3; in area 7 two apical dots instead of one; no cell-streak. Hw. s.-m. dots weak.

Hab.—French Islands, Witu, June 1925 (*F. Eichhorn*), 2 ♂ (type); *id.* June to August 1925, 1 ♂.

ssp. *cometho* (Godman & Salvin), 1888, Solomons.

Ups. of both wings with reduced white patches, and fw. with smaller subapical spots. Hw. with s.-m. dots large.

Hab.—Maleita.

ssp. *galacterion* (Fruhst.), 1906, Fergusson I. (= *strephon* Fruhst., 1906, Kapaur; *nora* Swinhoe, 1917, Kiriwina).

Resembles the nom. *affinis* form. Fw. subapical band wider, the spot in area 3 large. Rather variable over the whole area, but appears constant in the islands and usually darker in New Guinea.

form **kapaura** f. n.

♂. Ups. fw. with white patch in area 2 smaller and tinged with brown; posterior stripe narrower. Hw. band narrower. Uns. hw. with only slight white scaling in cell, or none at all; post-cellular white spots small and diffuse, little extended from the bases of areas 2 to 4.

Hab.—Dutch West New Guinea: Kapaur, 2 ♂ (type); Fak Fak, iv.–v.1908 (*A. E. Pratt*), 1 ♂; two days north of Fak Fak, xi.1907, 1700 feet (*A. E. Pratt*), 1 ♂. The specimen taken as type is from Coll. Fruhstorfer, and was labelled "*vorkeinus*".

form *vorkeinus* (Röber), 1886, Aru.

Ups. without discal white stripes. Hw. with small discal white area or white suffusion below the cell. Uns. hw. with white area very small or more extended as in nom. *galacterion*.

In the British Museum from Dutch New Guinea; a ♂ labelled "British New Guinea" is very like the original fig. of *vorkeinus* from Aru.

form *aruana* (Moore), 1883.

In the British Museum from Dutch New Guinea.

form *galacterion* (Fruhst.).

In the British Museum from the D'Entrecasteaux Islands, with types of *nora* Swinh.; Louisiade Islands.

forms undenominated.

Three variations are placed here provisionally in the absence of sufficient material.

(*a*) Resembles *adustus*, with very narrow subapical band.—Yanaba, Egum Is., ♂♀.

(*b*) Fw. with white patches large, on a brown ground. Hw. with large and short discal white area.—Yanaba, 1 ♂.

(*c*) Fw. subapical band as in *adustus*; a diffuse white spot in area 2; posterior stripe brown with slight white scaling. Hw. discal white patch as in *cometho*; s.-m. dots weak.—New Hebrides (H.M.S. *Dart*), 1 ♀.

ssp. *aruana* (Moore), 1883, Aru.

A dark form on the whole, but all transitions occur from a form in which the fw. discal patches are absent, to one in which the white patches are smaller than in Key Island specimens; subapical band narrower than in the Key form, and spot in area 3 smaller.

In the British Museum, also the Key Island form. Moluccas: Ceram and Gisser.

ssp. **tualana** ssp. n.

♂♀. Resembles the nom. *affinis* form. Fw. subapical band broader; spot in area 3 much larger than in nom. form or in *aruana*; usually a p.-d. spot in area 2, but when absent there is a streak in the cell. Hw. white band usually more extensive than in *aruana*. Uns. hw. with distal yellow-brown spots as in nom. form, not dark brown as in Papuan forms.

Hab.—Key Islands, 16 ♂, 21 ♀ (types ♂♀, June–July 1916, *W. J. C. Frost*); Tenimber Islands, 8 ♂, 8 ♀; Banda, 6 ♂, 2 ♀; Ceram and Buru, 5 ♂, 4 ♀.

ssp. *leucippus* (Röber), 1891, Timor (= *chionippe* Fruhst., 1910, Hulst., 1931, Bryk, 1937, *non* Hübner).

Ups. fw. with a brown cell-streak; discal white areas more or less edged with brown.

In the British Museum from Timor, Roma, Kisser, Wetter.

ssp. *coriacea* (Fruhst.), 1906, Alor.

Fw. on both sides with discal patches brown.

In the British Museum from Alor (one ♀, ex Coll. Adams, resembles *leucippus*), Pura, Dammer.

ssp. *littoralis* (Doherty), 1891, Sumba (= *tambora* Fruhst., 1899, Sumbawa).

Fw. discal patches brown. Hw. with prominent brown streaks, white band narrow.

In the British Museum from Sumba, Sumbawa (with ♂♀ types of *tambora*), Lombok.

ssp. *artenice* (Cramer), 1781, Java.

Hw. ups. without white markings; uns. without p.-d. white spots in nom. form.

form *kawiensis* (Fruhst.), 1899, E. Java.

Hw. uns. with post-cellular white spots.

form ?

♂. Brown areas proximally darker. Hw. with a post-cellular white spot in area 4, and a much smaller one in 3. Uns. with the spot in 4 much larger, a similar one in 5, and a small one in end of cell. Resembles f. *astakos* Fruhst. from Bawean, but with band of fw. white.

A single ♂ in the B.M., from Mt. Gedeh. In the British Museum from Batavia, ♂♀ (ex Coll. Fruhst.); Kangean Is., 1 ♂. Also ♂ type of *kawiensis*.

ssp. *fuliginosa* (Hagen), 1894, Bawean.

Rather variable. Fw. band usually broader than in *littoralis*. Hw., in most specimens, with white area reduced to a discal patch not reaching inner margin.

form *astakos* (Fruhst.), 1906.

Fw. band more or less dusted with brown. Hw. with discal white much reduced.

ssp. *djampeana* (v. Eecke), 1915, Tanah Djampea.

Fw. subapical band, and hw. discal band broader than in most *fuliginosa*.

The British Museum has 3 ♂ from Tanah Djampea, and 1 ♂ from Kalao.

ssp. *hegesippinus* (Röber), 1891, Bonerate.

Fw. as in *djampeana*. Hw. with a small discal white area.

ssp. *wenholti* (Martin), 1914, Saleyer.

Very doubtfully distinct from *hegesippinus*.

The preceding six forms, ranged provisionally as subspecies, have the following characters in common.

Fw., on both sides, without white scaling over the discal brown areas. Hw. with discal white band reduced, and only extending into area 5 as a small spot at the most.

It appears probable that only one subspecies should be recognised, and for this the oldest name is *artenice* (Cram.). A variable series of forms ranges from Java, Lombok, Kangean, and Bawean, to Sumba, Sumbawa, Kalao, Djampea, Bonerate, and Saleyer.

ssp. *fulgurata* (Butler), 1886, Macassar.

Fw. with a posterior white stripe, and hw. with discal white patch, both sharply prominent on a very dark gr.-col.

In the British Museum from South and East Celebes, and from Bangka Island (N.E. Celebes).

ssp. *decentralis* (Fruhst.), 1899, Sula Is.

Both wings with discal white patches larger than in *fulgurata*.

In the British Museum also from Banggai and Peling. A ♂ (ex Coll. Fruhst.) without locality, and bearing a type-label without name, has a prominent white cell-stripe on fw.

ssp. *taruna* (Fruhst.), 1899, Sangir.

Resembles *fulgurata*, but fw. uns. without discal white markings. Not constantly different from *fulgurata*.

ssp. *affinoides* (Fruhst.), 1899, Talaut Is.

Fw. subapical band rather broad; p.-d. patches large and white; a white cell-streak. Hw. with large discal white area, divided by the veins; s.-m. spots well developed, the spot in area 6 rather large.

ssp. *abigar* (Eschscholtz), 1821, Luzon (= *chionippe* Hübner, 1823; *ceciliae* Lesson, 1837, *in* Bougainville, *Journ. Nav. Thétis et l'Esperance*, p. 342, pl. 44, figs. 1, 1 bis).

The figure given by Hübner agrees well with Luzon specimens, and certainly not with Timor ones as supposed by some authors.

ssp. *malayana* (Fruhst.), 1899, Malaya.

Belongs to the *artenice* complex. Fw. very like *melanippus hegesippus*, but subapical band broader. Hw. discal band broad; s.-m. spots well developed.

Described from the figure by Distant, in *Rhop. Malay.*, pl. 42, fig. 11. In the British Museum also from Siam, and Nicobars (ex Bingham).

Apatela Group.

This group is represented by a single and peculiar species of which the ♂ is unknown. It seems to be placed best in *Danaus* on account of the short and broad cell of hind-wing.

Danaus apatela (Joicey & Talbot), 1925, Dutch New Guinea (Snow Mountains).

Resembles the ♀ of *D. schenkii periphas* (Fruhst.).

The British Museum contains 3 ♀, including type. All were probably taken by Meek, but remained unrecognised amongst the series of the common *periphas*.

Ismare Group (*Nasuma* Moore).

This group is represented by a single species.

Wings with white or brownish spots and stripes, and prominent antemarginal and submarginal dots and spots. Fw. with pointed apex and prominent apical white spot.

Danaus ismare (Stoll), 1782, Amboina.

Ranges over the whole of the Moluccas, Celebes, and islands north of Celebes; one form in Formosa.

ssp. *fulvus* (Ribbe), 1890, S.E. Celebes.

In the British Museum from Celebes, Bangka Island (north-east Celebes), Banggai, Talaut Is., Sangir, Peling.

Limniace Group (*Tirumala* Moore, *Melinda* Moore, *Elsa* Honrath).

Scent-organ of hw. a deep pocket which, on uns., is produced to a rounded flap extending over vein 2.

Danaus formosa (Godman).

With this species is united *mercedonia* (Karsch). According to van Someren (1936, *Journ. East Afr. and Uganda N.H. Soc.* **1**, Suppl.: 147) the two forms " overlap in their distribution, and in the area of contact, interbreed. Extensive material shows many intermediates. The area of overlap is from Lumbwa–Nandi to Elgon."

ssp. *formosa* (Godman), 1880, Gnuru Hills.

In the British Museum from Tanganyika Terr., Kenya, Uganda (Toro), Somaliland.

ssp. *neumanni* (Rothschild), 1902, Abyssinia.

ssp. *mercedonia* (Karsch), 1894, East Africa (Kirima).

In the British Museum from Uganda, Kenya (Kibwezi), Eastern Congo (Ituri to Kivu), West. Tang. Terr. (Mwanza).

ssp. *morgeni* (Honrath), 1892, Cent. Cameroons.

In the British Museum also from Nigeria (Kumbo), 1 ♂; Spanish Guinea, 1 ♂; Gaboon, 1 ♂.

Danaus limniace (Cramer).

Owing to the obscurity surrounding many Linnaean names the name *similis* Linn. has been used for *limniace* in recent literature, whilst *aventina* Cram. was used to replace *similis*. The Linnaean uncertainties have now been resolved by Corbet (1941*a*).

D. limniace may be confused with *hamata* (McLeay), the wings of both being similarly striped and spotted. In *limniace* the spots and stripes are larger and broader; fw. p.-d. spot in area 3 short and square, but in *hamata* it is elongate, and tends to be proximally pointed.

D. limniace is not recorded from Malaya or Sumatra.

ssp. *petiverana* (Doubl.), 1847, West Africa (= *phrynichus* Fruhst., 1910).

The type of this Fruhstorfer name is in the Brit. Mus. and is labelled " Collingwood Bay " !

ssp. *leopardus* (Butler), 1866, N.W. India (= *mutina* Fruhstorfer, 1910, Ceylon).

This forms part of a very variable series ranging from India to China, and tending to become darker eastwards. Judging from large material in the British Museum, there appears to be only one reliable character by which two subspecies may be distinguished. The posterior two stripes on fw. furnish the distinguishing character. Two variations occur : (*a*) The stripes are separated, with distal spot free; (*b*) the stripes coalesce, either together or with the distal spot. In *leopardus* the stripes are as in *b*.

ssp. *limniace* (Cramer), 1775 (= *norinia* Fruhstorfer, 1911, Hainan; *moaria* Fruhstorfer, 1911, Formosa).

Fw. with posterior stripes separated, and distal spot free.

In the British Museum from China, Formosa, Hainan, Tonkin, Cambodia.

ssp. *conjuncta* (Moore), 1883, Java.

Smaller than the continental forms. Fw. posterior stripes usually coalescent, and rarely with distal spot entirely free. Hw. spots relatively large.

In the British Museum from Java, Bali, Kangean, Bawean, Lombok, Sumbawa, Sumba, Kalao.

form *donia* (Fruhst.), 1897, Lombok.

Fw. posterior stripes only separated by a thin line, or entirely coalescent with each other and with distal spot.

ssp. *vaneeckeni* Bryk, 1937, Timor, Wetter (= *fruhstorferi* v. Eecke, 1915, *non* Röber, 1897).

Resembles *conjuncta*, but fw. posterior stripes usually separated.

In the British Museum from Timor and Flores.

ssp. *bentenga* (Martin), 1910, Saleyer.

Fw. posterior stripes coalescent. Hw. cell-streak vestigial or absent; s.-m. and ante-marginal spots small.

ssp. *makassara* (Martin), 1910, S. Celebes.

Hw. spots larger than in *betenga*; cell-streak well marked.

ssp. *orestilla* (Fruhstorfer), 1910, Luzon.

Judging from a pair in the British Museum this form resembles *limniace* (Cramer), but is smaller, and of the size of *conjuncta* (Moore). ♀ resembling *conjuncta* ♀, but with more extended white patches on hw.

Danaus hamata (McLeay) (= *melissa* Stoll, 1781, *non* Fabricius, 1775; *neomelissa* Bryk, 1937).

This species is to be distinguished from the similar *limniace* (Cram.) as explained under that species.

ssp. *musikanos* (Fruhstorfer), 1910, Ceylon.

A ♀ in the British Museum resembles *D. limniace petiverana* (Doubl.), in having the fw. posterior stripe absent.

ssp. *myrsilos* (Fruhst.), 1910, Java.

This comprises a large dark form (typical), and a smaller but larger spotted form.

form *myrsilos* (= *mistella* Swinhoe, 1915).

In the British Museum from Java, and types of *myrsilos* and *mistella*.

form *neomelissa* Bryk, 1937 (= *melissa* Stoll, 1781, *non* Fabr., 1775).

In the British Museum from Java, 22 ♂, 11 ♀; also from Bali, Bawean, Flores, Lombok, Sumbawa, Sumba.

ssp. *paryadres* (Fruhst.), 1910, Tenimber (= *singaria* Fruhst., 1910, Dammer).

The material comprising *paryadres* and *singaria* in Coll. Fruhstorfer, totalled only sixteen specimens. These are now in the B.M. with fifty-two others. This material exhibits the usual variation. Specimens from Aru tend to be darker, and more material may indicate an Aru race approaching the Moluccan one. The race *paryadres* is only just separable from *myrsilos* f. *neomelissa*, chiefly by the spots of fw. being more elongate.

In the British Museum also from Dammer, Letti, Roma, Moa, Babber, Wetter, Kisser, Alor, Timor, Key Is., Aru Is.

ssp. **talautensis** ssp. n.

♂. Smaller than *goana*, and more resembling *neomelissa* Bryk from Java. Fw. similar in facies to *neomelissa*; cell-spot divided; posterior p.-d. spot not united with posterior stripe, and divided or nearly so. Hw. with lower white cell-stripe thicker than in most Javan specimens; post-cellular spots shorter; p.-d. spots not large, placed farther from the post-cellular patches than in Javan specimens.

Hab.—Talaut Is.: "Salibaboe, ex Staudinger, 1899", 2 ♂ (ex Coll. Oberthür).

ssp. *arikata* (Fruhst.), 1910, Sula Is.

This is doubtfully distinct from *paryadres*.

ssp. *nigra* (Martin), 1910, Ceram.

Slightly differentiated from *paryadres*, the uns. being somewhat darker brown than in most of those, the spots somewhat smaller.

In the British Museum also from Amboina, Saparua, Buru.

ssp. *leucoptera* (Butler), 1874, Dorey.

In the British Museum from Gebi I., Waigeu, Mefor I., North-east Dutch New Guinea.

ssp. **pallidula** ssp. n.

♂♀. Fw. with posterior p.-d. spot usually merged with lower posterior stripe, but sometimes with upper stripe, being rarely free. Hw. distal area usually much paler than in *leucoptera*, and in a male from Humboldt Bay there is a broad greyish-white border; lower cell-streak and post-cellular stripes in areas 4 and 5 broader than in *leucoptera*.

Hab.—South-east Dutch New Guinea: Cyclops Mtns., Sabron, 1200 feet, May 1936 (*L. E. Cheesman*), 5 ♂, 1 ♀ (types); *id.*, 930 feet, April, 6 ♂ 4 ♀; *id.*, 930 feet, May, 1 ♂; Humboldt Bay, 2 ♂, 2 ♀; coast between Geelvink and Humboldt Bays, 2 ♂ (1 ♂ with hw. entirely brown like fw.); Astrolabe Bay, 4 ♂, 3 ♀ (1 ♂, 2 ♀ with hw. brown like fw. Mandated New Guinea: Munum, 15 miles up Markham River, 2 ♂; Finisterre Mtns., 1 ♂; Huon Gulf, 2 ♂, 1 ♀; "North New Guinea," 1 ♂, 2 ♀; Finschhafen, 3 ♂; "German New Guinea," 1 ♂; Kapia, 1 ♀; Vulcan I., 1 ♂, 1 ♀; Dampier Is., 5 ♀.

ssp. **subnubila** ssp. n.

♂♀. Resembles the nom. form from Australia. Spots and stripes somewhat smaller and narrower, hence the wings appear darker.

Hab.—British New Guinea: Aroa River (*A. S. Meek*), 5 ♂, 1 ♀ (types); Milne Bay, 1 ♂; Port Moresby, 1 ♂, 2 ♀; "New Guinea," 2 ♂, 2 ♀; Hall Sound, 1 ♀; "Goaribari," 1 ♀; Yule Island, 2 ♂, 1 ♀.

ssp. *coarctica* (Joicey & Talbot), 1922, Schouten Is.

A small race, resembling *paryadres*, with all markings strongly developed.

ssp. *obscurata* (Butler), 1874, Solomons (= *gariata* Fruhst., 1910, New Ireland).

Somewhat resembles *subnubila*, but hw. with paler distal area, somewhat as in *leucoptera*. Fw. with outer p.-d. spots in areas 2 and 3 much smaller; posterior stripes converging to distal spot which is usually united with the lower stripe. Hw. s.-m. spots usually weakly developed on ups.

In the British Museum from New Ireland, New Britain, Duke of York I., Mioko, Ulana, Gualdacanar.

ssp. **insignis** ssp. n.

♂♀. A large race, with markings similar to those of *obscurata*, but much more strongly developed. Fw. with anterior two subapical spots at least twice as large and more elongate. Hw. p.-d. spots much thicker and more elongate, the spot in area 1c, in ♂, purer white, usually with a proximal hook, when the spot near vein 2 is joined to it. The single female is paler; hw. with whitish distal border as in *pallidula*.

Hab.—Maleita Island, North-west Bay (*Woodford*), ♂♀ (types); *id.*, Saa (*Woodford*), 2 ♂; *id.*, Tyoh (*Woodford*), 1 ♂.

ssp. *neptunia* (C. & R. Felder), 1865, Fiji.

Fw. with cell-spot, cell-stripe, discal spots, and posterior stripes all absent; p.-d. spots white, large, elongate. Hw. without upper cell-stripe.

Form *protoneptunia* (Poulton), 1923, Fiji.

Fw. with all markings present, but cell-stripe thin or vestigial.

♀ f. *claribella* (Butler), 1882, Fiji (Viti).

A small form in which both wings have the proximal halves white, including the p.-d. spots above vein 4.

ssp. *angustata* (Moore), 1883, Tongatabu.

Stripes and spots large, the p.-d. series of both wings very prominent; therefore white areas more extensive than dark ones.

form **mendica** f. n.

♀. Markings as in *angustata*, but fw. without markings in proximal half, as in *neptunia*. Hw. without the anterior cell-streak. Uns. pale as in *angustata*, the fw. proximal half as above.

Hab.—1 ♀ labelled " Fiji ", the abdomen missing (ex Coll. Banks).

ssp. *hamata* (McLeay), 1827, Australia.

Resembles the Papuan forms, especially the southern one. All markings strongly developed, the fw. discal spot in area 2 being rather prominent.

Danaus ishmoides (Moore).

ssp. *ishmoides* (Moore), 1883, Celebes.

In the British Museum from North and South Celebes and Bangka Island.

A male from the Talaut Is. approaches the Jolo form. Fw. with p.-d. spots larger. Hw. post-cellular spots in areas 4 and 5 shorter and broader.

form **vetusta** f. n.

♂♀. Fw. cell-spot not divided; p.-d. spots (as distinct from discal ones near cell) larger. Hw. cell with a broad streak of the dark gr.-col.; post-cellular spots in areas 4 and 5 narrower and, at least in ♂, longer; p.-d. and s.-m. spots more strongly developed.

Hab.—South Celebes, Samanga, November 1895 (*H. Fruhstorfer*), 1 ♂ (type); Peak of Bonthain, 3000 to 6000 feet (*W. Doherty*, 1896), 1 ♀ (allotype); North Celebes, Tondano, 1 ♀ (ex Coll. Fruhstorfer).

ssp. **vetus** ssp. n.

♂♀. Nearer the form *vetusta* than to nom. *ishmoides*. Fw. markings as in *vetusta* except that the cell-spot is divided, and discal spots in areas 2 and 3 smaller; posterior stripes narrower, and in three out of four specimens with distal ends free from the longer proximal parts. Hw. as in *vetusta*. The specimen selected as type is small, with markings somewhat reduced.

Hab.—Jolo Is.: Siassi Is., 1 ♂, 2 ♀ (ex Coll. Adams).

ssp. *strymon* (Fruhstorfer), 1911, Mindanao.

In the British Museum from Mindanao and Luzon. One of the Mindanao males (from Dapitan) differs from Jolo specimens only in the longer and broader post-cellular patches in areas 4 and 5 of hw.

Danaus choaspes (Butler), 1866, Macassar.

Four subspecies are distinguished: Two from Celebes, one from Sula, and one from Mindanao.

Cleona Group (*Ravadeba* Moore).

Genitalia of species of the *cleona* and *melaneus* groups were figured by van Eecke in a little-known paper published in 1915 *Zool. Meded.* **1**: 211,

213. The bifurcate narrow-lobed uncus of the *cleona* group, and the broad rounded lobes of the uncus of the *melaneus* group are well shown.

Danaus aspasia (Fabricius), 1787, " Tranquebar," recte Siam (Fruhstorfer, 1910 : 205).

The known distribution of this species is extended by British Museum specimens of *thargalia* (Fruhst.), 1910, from Banka and Billiton, and of *philomela* (Zink.), 1831, from Kamodjan and Bali.

ssp. *annetta* (Swinhoe), 1915, ? Balabac.

Intermediate between the Borneo and Palawan forms. It was described as from Fergusson Island, off New Guinea; a male paratype bears this locality, and it seems incredible that the author really believed it ! The British Museum contains 2 ♂, 1 ♀, including types.

Danaus vitrina (Felder).

Closely allied to *aspasia*, which it replaces in the Philippines. Two subspecies may be recognised :—ssp. *vitrina* (Felder), 1861, Luzon; ssp. *oenone* (Butler), 1865, ? Mindanao (= *odrysia* Fruhst., 1910, Samar).

The ssp. *oenone* differs in the broader subapical band of spots, the spot in area 4 more extended proximad than in the nom. form.

In the British Museum from Negros, Bohol, Cebu, Mindoro, Mindanao, Samar.

Danaus cleona (Stoll).

Replaces *aspasia* farther east.

ssp. *luciplena* (Fruhst.), 1899, Celebes.

This name was used by Butler for Celebes specimens in the B.M., but appears never to have been published.

Fruhstorfer (1899, *Berlin ent. Z.* **44** : 158) records a note written him by Dr. Butler, who says he cannot trace a description of the name.

Westwood (1888, *Trans. ent. Soc. Lond.* **1888** : 471) cites " *luciptena* " Butler, meaning *luciplena*, and gives no reference or any sort of description. Similarly Rothschild (1892, *Iris* **5** : 431) cites the name.

Fruhstorfer (1899, *Berlin ent. Z.* **44** : 78) places *luciplena* as a subspecies of *cleona*, and gives a brief description; authorship must, therefore, be attributed to Fruhstorfer.

ssp. *keiensis* (v. Eecke), 1916, Key Is.

Described from a single example. No others known to me, and locality seems very doubtful.

Danaus schenkii (Koch), 1865.

This name clashes with *citrina* C. & R. Felder, 1865, and research shows that both names were published during the latter half of the year. Priority will be given, therefore, to the name selected by the first reviser. This appears to be Kirby (1871, *Syn. Cat.*), who, however, had no difficulty, since the Felder name was then supposed to have been published in 1867.

ssp. *distrata* (Fruhstorfer), 1910, Wetter.

Very close to the Key race (*talboti* Hülst., 1931) and perhaps identical. The types, with 2 ♂, 5 ♀ from Wetter and Kisser, are in the British Museum.

ssp. *citrina* (C. & R. Felder), 1865, Key, *recte* Aru (= *gloriola* Butler, 1866, Aru).

The figure of *citrina* in Felder *Reise Novara* represents the Aru form.

ssp. **omissa** ssp. n.

Very similar to *periphas* Fruhst., and differs chiefly in the ♀.

♂. Fw. subapical spot in area 4 longer than in *periphas* as a rule, being about 8 mm. along vein 4.

♀. Fw. with subapical spot in area 4, measured along vein 4, rarely less than 9 mm. as against 7·5 mm. or less in *periphas*; discal spot in 3 larger than in *periphas*.

Hab.—N.E. Dutch New Guinea: Dorey, 7 ♂, 6 ♀ (types from Andai); Wandesi, 3 ♂, 3 ♀; Manokwari, 1 ♀; Geelvink Bay, 1 ♂, 1 ♀; Amberbaki, 1 ♂; Artak, 1 ♀; Mioswar I., 1 ♀; West Dutch New Guinea: Kapaur, Fak Fak, Sorong, 3 ♂, 2 ♀; N. Dutch New Guinea: Djalan River, 3 ♂, 3 ♀; Wangaar River, 4 ♂, 4 ♀; Wangaar, 2 ♂, 2 ♀; Weyland Mtns., 1 ♂; S. Dutch New Guinea: Snow Mtns. and Eilanden River, 5 ♂, 2 ♀.

ssp. *periphas* (Fruhst.), 1910, Milne Bay.

In the British Museum from British New Guinea, Fergusson I., Yule I., Yanarba, Goodenough I., Woodlark I., St. Aignan and Rossell.

ssp. *schenkii* (Koch), 1865, New Georgia.

In the British Museum from Solomon Is., a series of both sexes; New Britain, 1 ♂ (ex Coll. Fruhst.), 1 ♂ (Webster) (ex Coll. Grose-Smith). No specimen from New Georgia.

Danaus clinias (Grose-Smith), 1890, New Ireland.

The characters of this large species are as distinct from *schenkii* as are those of *kirbyi*, and similarly it seems advisable to consider *clinias* as a species. Appears to be confined to New Ireland, and is so rare in collections that its special habitat is probably an area difficult of access.

♀ apparently unknown.

Danaus kirbyi (Grose-Smith), 1894, Humboldt Bay.

Facies rather different from that of *schenkii*. Hw. with *ldc* usually shorter than *udc*, and shorter than *ldc* of *schenkii* forms.

The races of *schenkii* are much less distinct from each other than is any one of them from *kirbyi*.

In the British Museum from Mandated New Guinea; form *kirbyi*; form *decolorata* (Fruhst., 1910) (♂ type from Hansemann Berg). Dutch New Guinea: form *kirbyi*, Gjellerup; form *decolorata*, Humboldt Bay; Cyclops Mountains, Sabron.

Danaus garamantis (Godman & Salvin), 1888, Gualdacanar.

It seems most improbable that this can be merely a race of *melusine* (Gr.-Sm.) under which Hulstaert (1931) has placed it, with *rotundata*. The ♂ is very different from any form of either.

Danaus pumila (Boisduval).

ssp. *pumila* (Boisduval), 1859, " New Caledonia."

The Oberthür Collection contained a single male from Coll. Boisduval. It bears a card label: " Pumila Bd. Nvlle. Caledon ". This may be the type, though the label is not Boisduval's own. It agrees with a series from the Loyalty Is. The type was received by Boisduval from Montrouzier via a M. Doué.

Hw. uns. with cell marked by a forked brown stripe, and the margins of cell edged with brown.

In British Museum from Loyalty Is., 7 ♂, 4 ♀.

ssp. *mariana* (Butler), 1865, New Caledonia.

Hw. uns. without markings in the cell.

Aglea Group (*Parantica* Moore).

Danaus agleoides (Felder), 1860.

Corbet, 1941*b* : 806 (= *Papilio eryx* Fabr., 1798, praeocc.).

ssp. **kangeana** subsp. n.

Intermediate between *furius* (Fruhst.) from Java and *erycina* (Fruhst.) from Nias. Spots smaller and lines thinner than in *furius*, especially the cell markings.

Hab.—Kangean Islands, Sapandjang, 6 ♂, 6 ♀ (ex Coll. Joicey).

ssp. *terilus* (Fruhstorfer), 1910, North Borneo.

It is strange that this form is so like the Nias one that I cannot find a distinguishing character. Those from Sumatra, Java, Nias, Kangean, and southern Borneo can all be differentiated.

Danaus aglea (Stoll).

ssp. *aglea* (Stoll), 1781, " Coromandel " (= *grammica* Boisduval).

A study of the figure published by Boisduval leaves no doubt that it represents *aglea aglea*. Type of *grammica* not in Coll. Oberthür.

Melaneus Group.

(*Chittira* Moore, *Caduga* Moore, *Megalisa* Moore, *Lintorata* Moore, *Badacara* Moore, *Chlorochropsis* Rothschild.)

Danaus melaneus (Cramer).

ssp. *melaneus* (Cramer), 1775, China (= *szechuana* Fruhst., 1899, Szechuan).

In the British Museum from Western China, northern Yunnan, Mishmi Hills.

ssp. *plataniston* (Fruhst.), 1910, Himalayas (= *neopatra* Fruhst., 1910, Sikkim).

This race has uns. hw. with reduced reddish-brown colouring, and increased white scaling over the light areas.

Danaus sita (Kollar).

ssp. *sita* (Kollar), 1844, Kashmir.

Form *sita*.—The original figure (♂) shows no line dividing the discal patches in areas 2 and 3 of fw., and no streak in cell of hw.

In the British Museum from Mussoorie, Assam, Yunnan, all nearly typical.

form **pedonga** f. n.

♂. Hw. with reduced brand, not extended above the fold in area 1*c*.

♂♀. Hw. uns. with reduced white scaling over vitreous areas; inner area with reduced light stripes, and stripe in area 1*a* absent or vestigial.

Hab.—Sikkim: Pedong (*A. Desgodins*) (ex Coll. Oberthür), 7 ♂ (type). The following 10 specimens, from Coll. Oberthür, were collected by *R. P. Bretandeau*:—Gnatong, 1894, 2 ♂; Tumlong, 1894, ♂♀; Kurseong, 1894, ♂♀; Senchal, 8000 feet, 1894, 1 ♂; Guntok, 1894, 2 ♀; Singlah, 1894, 1 ♀ (allotype). Gantok, 24–26.vii.1903 (Tibet Exp.), 1 ♂, 1 ♀; Darjeeling distr.?, Kalapahai, 6000–8000 feet, 8.vii.1917 (*Linton*), 1 ♀; "Darjeeling," 1 ♂, 2 ♀; "Sikkim," 3 ♂.

Bhutan: South-east, Trashiyangse, 5500 feet, 30.vii.1933 (*F. Ludlow* and *G. Sheriff*), 1 ♂; *id.*, 7500 feet, 12.viii.1933 (*F. Ludlow* and *G. Sheriff*), 1 ♂; Buxa (ex Coll. Moore), 1 ♂; "Bhutan" (ex Coll. Fruhstorfer), 1 ♀.

Mishmi Hills: Dingliang, 2450 feet, 14.iii.1935 (*M. Steele*), 1 ♂.

S.E. Tibet: Zayul, Atakang, 17.vi.1933, 8000 feet (*F. Kingdon Ward* and *K. J. H. Kaulback*), 1 ♂.

ssp. *niphonica* (Moore), 1883, Nikko.

In the British Museum from Japan, Loochoo Is., and Formosa. The name *loochooana* Moore, 1883, is a synonym.

Weiskei Group.

Hw. with cell broader; *ldc* about equal in length to *mdc*; scent-brand on vein 1*b*, reaching vein 1*a*, no brand on vein 2.

The true affinity of this group is obscure. It should, perhaps, be placed next the *Apatela* group.

Danaus weiskei (Rothschild).

ssp. *weiskei* (Rothschild), 1901, Aroa River.

ssp. *thalassina* (Joicey & Noakes), 1916, Dutch New Guinea: Arfak Mtns.

Similis Group (*Radena* Moore).

(See note under *limniace*, page 133.)

Danaus similis (Linn.), 1758. S.E. China.

D. aventina Cram., Talbot, 1939 : 288.
D. similis Linn., Corbet, 1941*a* : 19, 27; *id.*, 1941*b* : 166.

Three subspecies.

Danaus vulgaris (Butler), 1874. Java (= *vulgaroides* Fruhst., 1904).

D. vulgaris Talbot, 1939 : 289.

Ten subspecies.

Danaus juventa (Cramer).

Under this name is comprised a very variable series of forms ranging from the Nicobars and Malaya to Papua, the Bismarck and Solomon Islands.

The series of typical light forms extends east to Sumba and the Sula Islands. Within the area from the Moluccas eastwards the *juventa* forms are darker, except in Waigeu and New Guinea, where a series of light forms occurs. The dark forms appear related to *vulgaris*. No series of both forms has been taken together, though a few specimens of each are to be found labelled as from the same locality.

It seems advisable, therefore, to treat all the forms as belonging to one species.

In all the forms the inner stripes (at least the anterior of the pair) of fw. are thicker, usually much wider, than in *vulgaris* or *similis*.

The dark *sobrina* (Boisd.), from N.E. New Guinea, resembles *vulgaris* much more closely than it does *juventa*.

The form *nicobarica* (Moore) is, in some respects, like *similis*, and in others like *juventa*.

ssp. *nicobarica* (Wood-Mason & de Nicéville), 1881.

This is placed under *juventa* on account of the larger inner stripes of fw., and white cell of hw.

Most authors have considered *nicobarica* to be a race of *similis* (L.). The latter is distinguished from *juventa* by the aedeagus being furnished with a "brush" on the vesica, similar to that found in the Melaneus group. In *juventa* the vesica bears a small dentate plate. There is no obvious difference between the genitalia of *nicobarica* and of *robinsoni* (Roths.) from Sumatra.

In the British Museum from Great Nicobar, S. Nicobars, and Camorta.

ssp. *sitah* (Fruhstorfer), 1904, Natuna.

Differs slightly from the Java race in hw. post-cellular patches being smaller.

In the British Museum also from Sarawak. Also known from Malaya (Tioman I.), and the Riouw Lingga Is.

ssp. *kinitis* (Fruhstorfer), 1904, Sandakan.

In the British Museum also from Palawan.

A form described from West Borneo as *simillima* v. Eecke is probably this, or it may be *sitah*. The description is vague, and comparison is made with *similis* Clerck !

ssp. **suluana** ssp. n.

♂♀. Light areas more compact than in *kinitis*, and very narrowly separated by the black veins; s.-m. spots of both wings more prominent.

Hab.—Sula Is., 2 ♂, 2 ♀ (types), 1 ♂ (*Pryer*).

ssp. *hadrumeta* (Fruhstorfer), 1911, Bohol (= *messana* Fruhst., 1913, Mindanao).

Similar to *kinitis*. Fw. patches in areas 2 and 3 distally pointed as in *kinitis*; cell-spot usually well separated from the basal streak. Hw. post-cellular patches somewhat narrower than in the Borneo and Java forms, especially in the ♀.

In the British Museum from Mindanao, Samar, Mindoro, Luzon, Bohol.

ssp. *manillana* (Moore), 1883, Luzon (= *galaecia* Fruhst., 1910, " Philippines ").

Both wings with larger patches, and well-developed s.-m. and antemarginal spots.

This is possibly a mountain form.

ssp. *garia* (Fruhstorfer) (non *goria* auct.), 1904, Bazilan.

Differs from *hadrumeta* in the fw. antemarginal dots being less distinct, and in the smaller post-cellular patches of hw.

ssp. *luzonica* (Moore), 1883, Babuyanes.

Fw. patches in areas 2 and 3, and cell-spot, much smaller than in other Philippine races; hw. post-cellular patches narrower. ♀ much darker than in other Philippine races. A female from the Camotes approaches *garia*.

In the British Museum from Babuyanes (types); Camotes, " Philippines."

ssp. *robinsoni* (Rothschild), 1920, West Sumatra.

A light form, with larger patches than in Java race. Both wings with very strongly developed s.-m. spots and antemarginal dots.

ssp. *pseudosimilis* (v. Eecke), 1915, Sumatra (Lampong Tapanoeli).

Larger than the Javan race, with smaller and narrower patches, especially on hw., where patch in area 2 is distally pointed, and the one in 3 is much smaller than that in 4.

In the British Museum from Madang, Padang, and Kroë; also from Banka.

ssp. *scrobia* (v. Eecke), 1915, Billiton.

Doubtfully distinct from the Java race; fw. patches may be a trifle larger.

ssp. *juventa* (Cramer), 1777, Java (= *mincia* Fruhst., 1910, Bawean; ? = *krakatanae* Moulton, 1921, Krakatoa).

A light form with all markings well developed.

In the British Museum from Java, Bali, and Bawean.

ssp. **sapana** ssp. n.

♂♀. The lightest *juventa* form. Markings yellowish, and all extended, the outer dark borders being narrower than in other forms. Fw. cell-patch especially large, and usually joined to basal stripe. Both wings with well-developed s.-m. spots and antemarginal dots.

Hab.—Kangean, 7 ♂, 7 ♀.

ssp. *sequana* (Fruhstorfer), 1910, Tukang Besi Islands (Binongka).

The type is very close to *kallatia* (Fruhst., 1904) from Kalao, but is purer white; fw. spots in area 4 connected by a narrow streak. Doubtfully distinct.

ssp. *ishma* (Butler), 1869, S. Celebes.

In the British Museum from south, north, and east Celebes; Buton and Banggai.

The name *libussa* Fruhst., 1904, Banggai, is a synonym.

The names *tawaya* (Fruhst., 1904), Central Celebes; *ultramontana* (Martin, 1914), west-central Celebes; and *tontoliensis* (Fruhst., 1897), north-east Celebes, may be regarded provisionally as subspecies; specimens of each are in the British Museum.

ssp. *curtisi* (Moore), 1883, Batjan (= *sobrina* auct., *non* Boisduval).

A very dark form. In the British Museum from Batjan, Ternate, and Halmaheira.

ssp. *meganire* (Godart), 1819, S. Moluccas (= *buruensis* Holland, 1900).

Similar to *ellida* (Fruhst.) from Obi. Individual variation relatively very slight, and Buru specimens certainly not distinct.

In the British Museum from Buru, Amboina, Ceram, Gisser, Nausa Laut.

form *ogylla* (Fruhst.), 1910, "Aru."

Similar to *meganire*, but purer white, and markings larger, spot in area 3 of hw. especially prominent.

The male type, in Coll. Fruhstorfer, agrees exactly with 2 males from the Matabello (Watubella) Is., situated between Key and Aru. The Matabello males were collected by Mr. W. J. C. Frost on 11th September, 1916. Mr. Frost also collected largely in the Aru Is., but did not obtain a specimen of *juventa*. It seems most probable, therefore, that the Fruhstorfer male did not come from Aru.

In the British Museum from Matabello Is.; "Aru," ♂ type; Bomfia, Ceram. Certain other males from Ceram are very near this form.

ssp. **bosnika** ssp. n.

♂♀. Resembles *curtisi* (Moore), but markings more developed, though not to such an extent as in *ellida*. Fw. basal streak well marked. Hw. with hooked cell-stripe as in *sobrina*; post-cellular patches narrower than in *ellida*, the s.-m. and antemarginal spots much the same as in that form.

Hab.—Schouten Is., Bosnik, Biak, June 1914 (*A.*, *C.*, & *F. Pratt*), 6 ♂, 6 ♀.

ssp. *sobrina* Boisduval, 1832. Buru and New Guinea (text), Vanikoro (plate).

The insect figured by Boisduval represents the dark form found in North-east New Guinea. No specimen from the Boisduval Collection was found in Coll. Oberthür.

Fw. similar to *curtisi*; spots somewhat larger; inner stripes shorter and well separated. Hw. as in *bosnika*, but markings more reduced, and antemarginal dots vestigial.

In the British Museum from North-east Dutch New Guinea.

ssp. *purpurata* (Butler), 1866, Salawatty?

Markings more as in typical *juventa* forms. Fw. patches large; inner stripes joined, or divided by a thin line, the upper stripe much broader than the lower one; basal streak linear; patch in area 3 distinctly smaller than cell-spot; s.-m. spots prominent; ante-

marginal dots usually absent. Hw. cell entirely white; post-cellular patches narrow, short, spot in area 3 minute; s.-m. spots weakly developed, and antemarginal dots usually absent.

In the British Museum from Salawatty, Waigeu and Misol. The types probably came from Salawatty.

ssp. *tanais* (Fruhst.), 1904, Mefor.

Resembles *purpurata*. A male in Coll. Fruhstorfer, from Dutch South-west New Guinea, is labelled "*piadina* type"; this name appears to be an unpublished one.

In the British Museum from the islands of Mefor, Jobi, Roon, Amberfron, Mioswar, Ron. Dutch New Guinea: Dorey, Arfak, Wandesi, Amberbaki, Coast District, Geelvink Bay, Wandammen Mtns., Wangaar and Djalan Rivers.

ssp. *kolleri* (Hulstaert), 1923, South-west Dutch New Guinea, Merauke.

According to the figure given by Hulstaert (1931), this insect is unlike any other *juventa* from New Guinea, and resembles Indo-Malayan forms.

ssp. **hollandia** ssp. n.

♂♀. Fw. cell-spot produced basad, and usually merged with basal stripe as in *metaxa* Fruhst.; spot in area 3 absent or minute, rarely prominent; the lower of the two inner stripes shorter than the upper one, but the two are usually connected, the upper stripe wider than in *tanais*. Hw. rarely with a dot in base of area 3, but otherwise as in *tanais*. ♀ sometimes dusky; fw. basal streak obsolete.

Hab.—North Dutch New Guinea: District between Geelvink Bay and Humboldt Bay (*W. Doherty*), 11 ♂, 6 ♀ (types); "North New Guinea," 6 ♂, 2 ♀; Cyclops Mtns., Sabron, 930 feet, iv.1936 (*L. E. Cheesman*), 4 ♂, 4 ♀ (two of these females are dusky); Gjellerup, 1911, 1 ♂; Altape, 10.xi.1936 (*L. E. Cheesman*), 2 ♂; Humboldt Bay, 2 ♂, 1 ♀; Kapia, 1 ♂.

ssp. *metaxa* (Fruhst.), 1910, Finschhafen.

Fw. cell-spot large, merged with basal stripe; inner stripes of normal length, coalescing distad; spot in area 3 large, placed midway between end of cell and s.-m. spot; antemarginal dots more or less developed. Hw., in ♂, with a dot in base of area 3; s.-m. and antemarginal spots developed; otherwise as in *hollandia*.

In the British Museum from Mandated New Guinea: Finschhafen and Huon Gulf.

ssp. *eugenia* (Fruhst.), 1906, Astrolabe Bay.

Resembles *metaxa* but markings reduced. Fw. inner stripes shorter, narrower, and separated. Hw. cell with lower veinlet usually darkened, and in ♀ the cell anteriorly dusky; ♂ rarely with a dot in base of area 3.

In the British Museum from Mandated New Guinea: Stephansort, Friedrich-Wilhelmshafen, Astrolabe Bay. Vulcan Is., Dampier Is., Rooke Is.

ssp. *sobrinoides* (Butler), 1882, New Britain (= *mangalia* Fruhst., 1904, Shortland; *ribbei* Fruhst., 1906, New Ireland).

Resembles *eugenia*.

In the British Museum also from New Ireland, New Hanover, Admiralty

Is., Duke of York I., Mioko, Gualdacanar, Shortland, Choiseul, Bougainville, Florida, Rubiana.

A male in Coll. Fruhstorfer, from Shortland, was labelled *mangalia*, and as no specimen bore a type-label this specimen was selected as type.

The ♀ allotype of *zanira* (Fruhst.) is labelled " Bougainville ".

ssp. *zanira* (Fruhst.), 1904, Hab. ?

Markings as in *sobrinoides* but much more developed. Fw. cell-spot large, joined to basal stripe, though latter, in ♀, usually suffused. Hw. cell less darkened anteriorly than in *sobrinoides*; s.-m. spots prominent.

In the British Museum from Maleita, Savo Island. The ♂ type bears no locality, but agrees with the Maleita specimens.

A male, labelled " N. Britain " (ex Coll. Crowley), probably belongs here.

Markings more white. Fw. basal stripe heavy, and merged gradually into cell-spot; inner stripes very narrowly separated by a dark line. Hw. cell not darkened.

Danaus oberthuri (Doherty), 1891, Sumba.

This insect, though obviously derived from *juventa*, is so different in appearance that it cannot be ranked with the forms of that species.

List of New Forms described.

D. gilippus wheeleri ; ♀, Colombia.
D. eresimus estevana ; ♂♀, Venezuela; Colombia.
D. eresimus montezuma ; ♂♀, Central America.
D. chrysippus f. *amplifascia* ; ♂♀, India, China, Tonkin.
D. plexippus f. *albipars* ; ♂♀, Sikkim, Burma.
D. plexippus sumbana ; ♂♀, Sumba.
D. philene fuscata ; ♂, Bangka I., north-east Celebes.
D. philene mytilene f. *signata* ; ♂, Mioswar, N.E. New Guinea.
D. philene sabrona ; ♂♀, Dutch New Guinea.
D. philene ferruginea f. *oesypera* ; ♂, British New Guinea.
D. affinis albistriga ; ♂♀, Loyalty Islands; New Hebrides.
D. affinis bipuncta ; ♂, French Islands.
D. affinis galacterion f. *kapaura* ; ♂, West Dutch New Guinea.
D. affinis tualana ; ♂♀, Key Is., Tenimber, Banda, Ceram, Buru.
D. hamata talautensis ; ♂, Talaut Islands.
D. hamata pallidula ; ♂♀, Dutch and Mandated New Guinea.
D. hamata subnubila ; ♂♀, British New Guinea.
D. hamata insignis ; ♂♀, Maleita Island.
D. hamata angustata f. *mendica* ; ♀, " Fiji," ? Tonga.
D. ishmoides ishmoides f. *vetusta* ; ♂♀, Celebes.
D. ishmoides vetus ; ♂♀, Jolo Islands.
D. schenkii omissa ; ♂♀, Dutch New Guinea.
D. agleoides kangeana ; ♂♀, Kangean Islands.
D. sita sita f. *pedonga* ; ♂♀, Sikkim, Bhutan, Mishmi Hills, S.E. Tibet.
D. juventa suluana ; ♂♀, Sulu Islands.
D. juventa sapana ; ♂♀, Kangean Islands.
D. juventa bosnika ; ♂♀, Schouten Islands.
D. juventa hollandia ; ♂♀, Dutch New Guinea.

	Ceylon	India	Burma	Andamans	Nicobars	China	Formosa	Hainan	Indo-China	Neomalaya	Paramalaya	Java	Palawan	Philippines	Celebes and Sula Is.	Lesser Sunda Is. to Tenimber	Moluccas	Key and Aru Is.	New Guinea	Australia	New Hebrides and New Caledonia	Solomon Is.	Bismarck Is.	Fiji	Tonga and Samoa
	7	8	13	6	9	8	10	9	13	15	8	12	7	12	14	11	7	6	10	5	4*	7	8	2	1
Plexippus Group																									
chrysippus (L.)	×	×	×××	×	××	×	×	×	×	×	×	×××	×	×××	×××××	×××	×	×	×	×××	×				
melanippus (Cram.)																									
plexippus (L.)	×	×	×××	×	××	×	×	×	×	×	×	×××	××	×××	×××××	×××	××	×	××	×××	×	××	××	×	
phlene (Stoll)																									
affinis (Fabr.)																									
Apatela Group																									
apatela (J. & T.)																			×						
Ismare Group																									
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Limniace Group																									
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hamata (McL.)*																									
gautama (Moore)																									
ishmoides (Moore)																									
choaspes (Butl.)																									
Aglea Group																									
agleoides (C. & R. Feld.)																									
aglea (Stoll)	×	×	××	××	××	×	×	×	××	××	×	×			××										
Cleona Group																									
aspasia (Fabr.)																									
vitrina (C. & R. Feld.)																									
cleona (Stoll)			×						×	×	×	×	×	×	×		×								
scherzeri (Koch)																									
clinias (Gr.-Sm.)																									
kirbyi (Gr.-Sm.)																									
garamantis (G. & S.)																									
rotundata (Gr.-Sm.)																									
melusina (Gr.-Sm.)																									
pumila (Boisd.)																									
Melaneus Group																									
taprobana (C. & R. Feld.)	×																								
nilgiriensis (Moore)		××																							
melaneus (Cram.)			×			×	××	×	×	×	×	××	×			×									
luzonensis (Feld.)																									
phyle (Feld.)																									
albata (Zink.)																									
menadensis (Moore)																									
sita (Koll.)		×	×			×	×	×	×	×		×			××	×									
weiskei (Roths.)																									
Similis Group																									
similis (L.)	×		××			×	×	×	××	×××	×	×	××		×	×××		×	×			×			
vulgaris (Butl.)																									
juventa (Cram.)					×																				
eberthuri (Doh.)																									
37 Total species																									

Distribution of *Danaus* in the Indo-Australian Region.
(* *D. hamata* is not known from New Caledonia.)

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THE VARIATION IN ADULT STRUCTURE OF *LUFFIA FERCHAULTELLA* (STEPHENS) (LEPIDOPT., PSYCHOIDEA)

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(1) *Introduction and an Account of previous Work.*

The Psychid moths of the family Luffiidae consist, according to Tutt, of the genera *Luffia* and *Bacotia*. The former genus contains the two species *L. lapidella* (Goeze) and *Luffia ferchaultella* (Stephens), while the latter genus has only the single species *B. sepium* (Speyer).

In all these species the female is apterous and the male (when present) is winged. The family forms an intermediate group between the Micro- and the Macro-Psychids. The characters indicating this position have been outlined by Tutt (1900 : 229) and also by Chapman (1899).

Of the two species in the genus *Luffia*, as defined by Tutt, *L. lapidella* is regarded as a bisexual species having larvae which feed on rock-lichens, while *L. ferchaultella* is a parthenogenetic species the larvae of which are largely found on tree-lichens. A review of the characters distinguishing these two species has been made by McDonogh (1941) together with an account of their morphology.

The fact that *L. ferchaultella* has apterous females and is parthenogenetic suggests that distinct races might exist in different parts of its range as a result

of the absence of cross-breeding, and the apparent lack of an easy mode of migration. This suggestion was first put forward by Chapman (1899). He enlarged on this subject in a later paper (1901), where he remarked that while specimens of *L. lapidella* in such widely different localities as Italy, Switzerland, France and the Channel Isles do not vary at all, specimens of the smaller *L. ferchaultella* are very variable.

Chapman described two or three forms such as :—(1) *L. ferchaultella* occurring on the rocks in Cannes, where it was parthenogenetic, and had ovipositor rods 3·6 mm. long. The shortest rods in *L. lapidella* are 3·8 mm. long. Tarsal formula of this parthenogenetic type was 4–4–4. (2) A form of *L. ferchaultella* from Lurgashall in Sussex with a tarsal formula of 4–4–4, which occasionally " calls," *i.e.* female extends abdomen as if attracting males. At other English localities *L. ferchaultella* has a formula of 3–4–4 or 3–3–3, and is " non-calling."

Chapman refers in this paper to a variety of *L. ferchaultella* which, like *L. lapidella*, " calls " immediately after emergence yet lays fertile eggs without mating. He named this calling form *L. maggiella*.

Several specimens of *L. ferchaultella* have been bred during this investigation which appeared to be " calling " after they had emerged.

There is a similar list of forms in Tutt (1900), included in his comparison of the two species of *Luffia* :—

" Female of *L. lapidella*.

Antenna 14-jointed; tarsi 4–4–4 (3–4 partly anchylosed in the 1st legs); scales ¼ length n breadth, usually truncate.

" Female of *L. ferchaultella*.

(i) Antenna 12-jointed; tarsi 3–4–4; scales narrower than those of *L. lapidella*, ⅕ of length in breadth, truncate and very rarely rounded; fore-wings narrow but long; metathorax partly pale. Broxborne, Horsham. (ii) Antenna 12-jointed; tarsi 3–4–4; scales variable from length equal to breadth to length 5 × the breadth, truncate, very rarely rounded. Bignasco (Italy). (iii) Antenna 12-jointed; tarsi 3–3–3; scales very broad, length only 2 × breadth; metathorax dark brown. Bowers-Gifford. (iv) Antenna with fewer than 12 joints; tarsi 3–3–3; scales from length equal to breadth to length 2 × breadth. Deal."

(2) *Characters measured and Definitions.*

The adults of *L. ferchaultella* bred from larvae and pupae collected in various localities over the south of England have exhibited a considerable degree of structural variation.

The characters studied were :—(1) Maximum width of the head, measured across the eyes. (2) Antennal segmentation (referred to as Ant. no.). (3) Tarsal formula, *i.e.* 3–4–4 means that the fore tarsi have three segments, and the mid and hind tarsi four. (4) Tarsal number, which is the total number of tarsal segments present in an individual. (Referred to as T.N., a 3–4–4-individual would have a T.N. of 22.) (5) Lengths of three ovipositor rods which for convenience were referred to by the letters A, B, C, D. The strut of segment VIII is termed Ovipositor rod A. The strut of segment IX is called Ovipositor rod B. The accessory strut of segment IX is rod C, the length of the two arms of this strut were measured as rod D. (6) The length and breadth of the fore-wing were combined as one ratio, length divided by breadth being called wing-ratio, and usually referred to as " wing." The hind-wing was not

constantly present; it was not studied in detail though its presence or absence was noted.

The measurements were direct counts of segments in the antennae and tarsi. The head-diameter and wing-ratios were measured by means of a monocular microscope using an eyepiece scale in a 10x eyepiece with a $\frac{2}{3}$-inch objective. The ovipositor rods were measured by using the same eyepiece in a binocular microscope with a 65-mm. objective. The sizes of these structures are given here in mm. An exception to this occurs in the frequency diagrams where it was more convenient to retain the micrometer scale measurements. The necessary factors are given on these diagrams for converting them to millimetres.

In addition to the actual sizes of the structures studied, a number of ratios were obtained both for localities and for individuals. The ratios used were Ovipositor rod B/Ovipositor rod A referred to as ratio B/A, similarly ratio A/C, Head Diameter/Antennal number,[1] Head Diameter/Tarsal number, and Antennal number/Tarsal number. These ratios were calculated from the average size of the characters obtained for each locality studied. It was found that the ratios so obtained did not differ from the values for the same localities calculated by averaging the individual ratios of the specimens from these places by more than one per cent. This indicates that the measurements used to form the ratios were normally distributed. It should be noted, however, that the tarsal numbers are an exception to this generalisation (see p. 165).

(3) *Correlations between Characters.*

The length of the ovipositor rods, number of tarsal segments, and the number of antennal segments are quite closely correlated with the head-diameter. In a given colony, for instance, the individuals were grouped according to units of head-diameter. The mean tarsal number for each class of head-diameter was calculated. The correlation coefficient between head-diameter and the mean tarsal number was then calculated in the ordinary way. Significant correlation coefficients of +0·86 to +0·92 were obtained for the average sizes in the nine classes of head-diameters. The averages used in each head-class were calculated from varying numbers of individuals, the minimum number being 18 for the extreme types of head-diameter. The six intermediate head-classes consisted of up to 180 individuals.

For individual localities the correlation coefficients were much lower, and in many cases were not significant. Head-diameter × Antennal number gave values about +0·28 to +0·34, while Head × Tarsal number varied from +0·26 to +0·32. These averages were based on up to 20 individuals per head-class. The extreme sizes had only few individuals and this is probably the reason why the coefficients are as low as they are.

The wing-ratio appears to be the most independent character. It is far less variable than are the other characters, which are all more or less dependent on the total size of the individual. The effect of varying tarsal number on the sizes of the other characters is shown in figs. 3–6; also see p. 165.

(4) *Variation in Measurements of Structures.*

Histograms showing the frequencies of the various sizes of the structures measured are shown in figs. 1 and 2. The figures for these are tabulated below.

[1] The head-diameter is given in micrometer divisions for convenience in these ratios; if the actual diameter in mm. were used the ratios would be of the order of 0·035 instead of 2·0.

All the characters studied fit a monomodal frequency with the exception of the antennal segmentation and the tarsal number. The former is in the form of a half-frequency curve showing a sudden drop after the maximum point; in this example when the number of segments is 12. The tarsal number exhibits

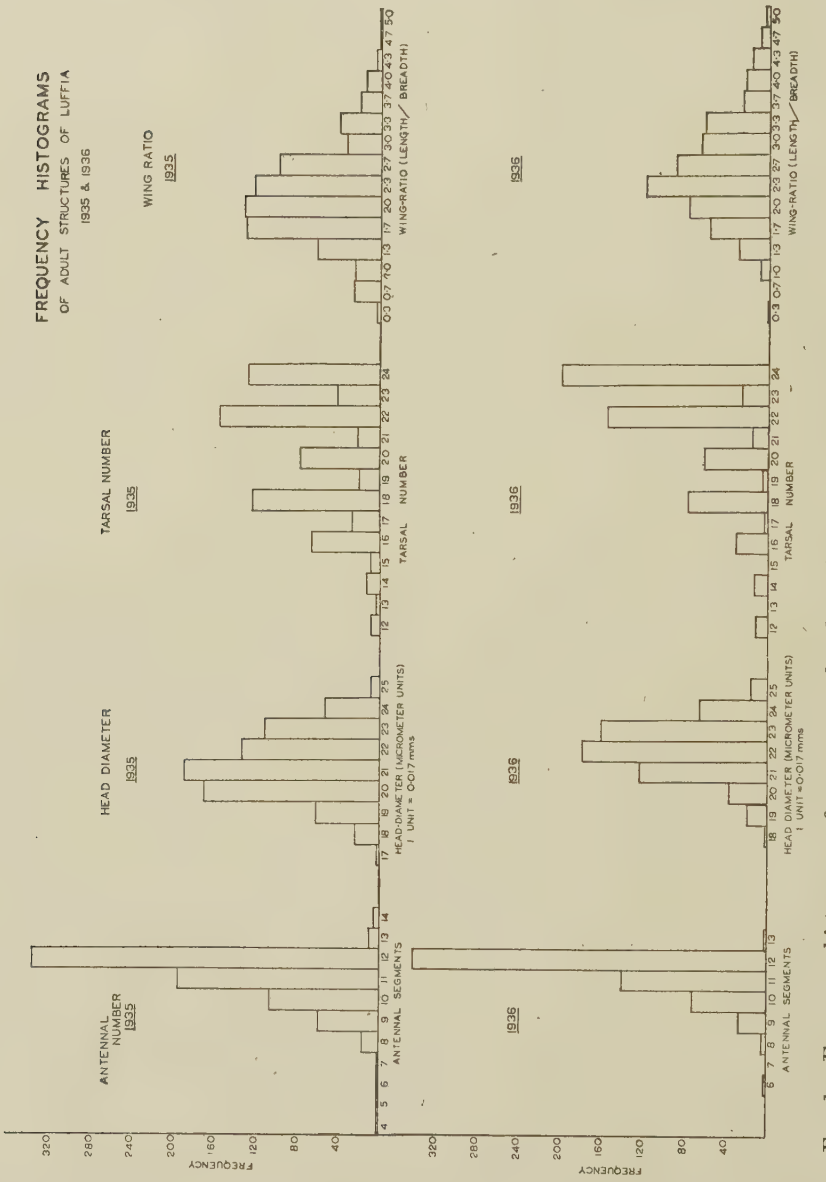


Fig. 1.—Frequency histograms of antenna number, head-diameter, tarsal number and wing-ratio in 1935 and 1936.

an irregularity due to the tendency of the tarsal formula to have stable types which are symmetrical, the two formulae 3–3–3 and 4–4–4 predominating because of this. The group with a tarsal number of 22 is not a homogeneous one since there are several possible formulae having this value. The tarsal

number histogram reaches its maximum at 22, after which there is a sudden drop.

During 1936 further measurements were made of the adults bred in that year with a view to studying the effect of various factors on the character sizes.

The frequency histograms for each character are again monomodal, with the two exceptions noted during the previous year, tarsal number and antennal segment number.

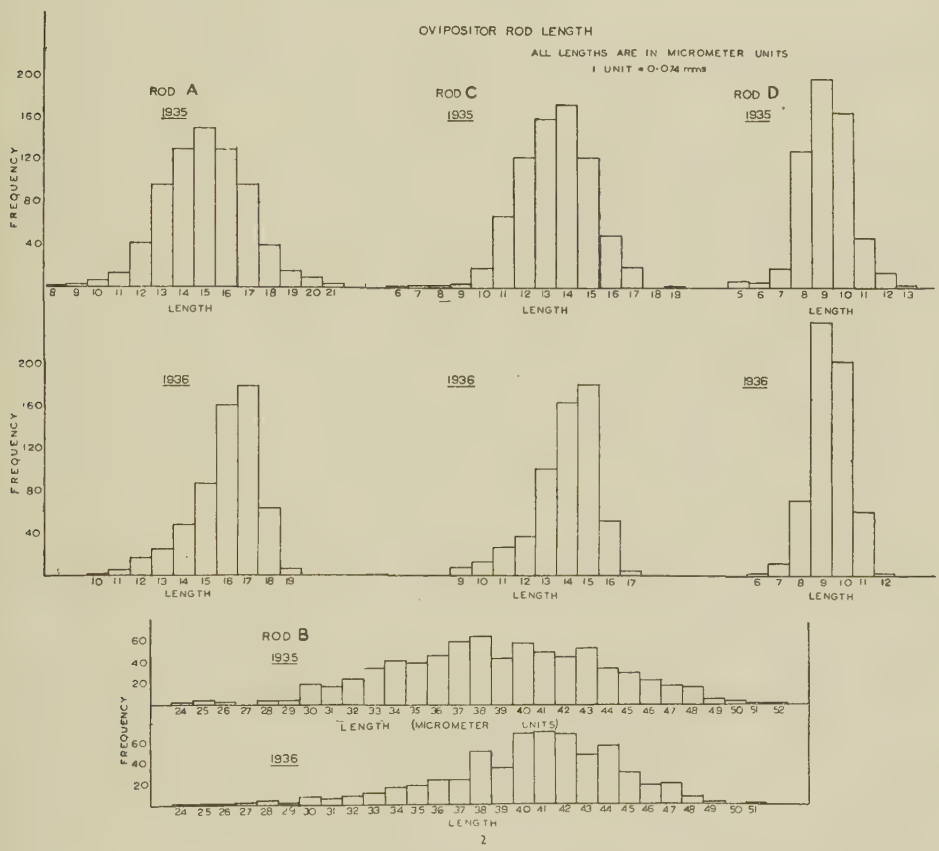


FIG. 2.—Similar histograms for ovipositor rods A, B, C, and D.

Apart from the tarsal number, these histograms give no structural evidence indicating the occurrence of distinct races over the area examined but rather suggest one very variable species.

TABLE I.

Frequencies of head sizes in *L. ferchaultella*.

Head-diam., mm.	0·289	0·306	0·323	0·340	0·357	0·374	0·391	0·408	0·425
Freq. in 1935 . .	2	23	61	169	188	132	110	52	8
Freq. in 1936 . .	0	2	19	36	122	171	159	64	15

There was one individual in 1936 with a head-diameter of 0·459 mm. The above figures are not used in the histograms in fig. 1. It was more convenient to retain the micrometer scale units in these diagrams. The actual sizes can be obtained from the conversion figures given on the diagram.

TABLE II.

Frequencies of antennal numbers.

Antennal number	4	5	6	7	8	9	10	11	12	13	14
Freq. in 1935 .	1	1	1	1	16	58	105	194	335	9	5
Freq. in 1936 .	—	—	2	0	4	26	71	139	341	2	—

The more restricted range in the 1936 sizes is probably due to the fact that the adults used in that year came from comparatively closely situated localities. The 1935 adults were from localities so far apart as Stonehenge (Wilts), Brighton (Sussex), Oxford, and Ipswich (Suffolk).

TABLE III.

Frequencies of occurrence of tarsal number (T.N.).

T. number	12	13	14	15	16	17	18	19	20	21	22	23	24
Freq. 1935	8	3	12	8	65	26	122	19	76	21	154	40	126
Freq. 1936	11	0	12	0	30	3	76	5	60	14	153	24	197

It might be assumed that the odd tarsal numbers, 13 to 23, were "imperfect" examples of the even numbers on either side of them. In Table IV, therefore, the number of individuals having odd numbers has been divided into two groups and added to the even numbers on either side. The number to be divided is split into parts proportional to the even numbers on each side of it, *i.e.* where 20, 9, 10 are three frequencies (the middle one having an odd number of segments) 6 are added to the "20," and 3 are added to the "10"; the amended frequencies then being 26 and 13 for the two even number types.

TABLE IV.

Amended frequencies of T.N.

T. number	12	14	16	18	20	22	24
Freq. in 1935 .	9	15	81	152	89	190	144
Freq. in 1936 .	11	12	31	80	67	173	211

It will be seen that the frequencies are still bimodal when the odd numbers have been accounted for. A histogram from these figures has not been included.

In the first column of Table V it will be seen that the frequencies for 1935 give an almost perfect histogram of normal frequency.

In the second column, giving the frequencies of rod B, it was found best to give the frequencies for adjacent pairs of lengths as well as for each length.

Each micrometer scale division was equivalent to approximately 0·073 mm. and the rod lengths were taken to the nearest scale division.

TABLE V.

Frequency of occurrence of ovipositor rod lengths.

Length, mm.	Frequency							
	A.		B.		C.		D.	
	1935	1936	1935	1936	1935	1936	1935	1936
0·37	—	—	—	—	—	—	6	—
0·44	—	—	—	—	1	—	5	2
0·52	—	—	—	—	2	—	18	11
0·59	1	—	—	—	2	—	129	71
0·67	2	—	—	—	3	7	198	240
0·74	6	1	—	—	18	12	166	203
0·81	13	5	—	—	68	26	46	60
0·89	41	16	—	—	123	36	14	2
0·96	96	24	—	—	160	100	2	—
1·04	130	47	—	—	174	163	—	—
1·11	150	86	—	—	123	180	—	—
1·18	130	160	—	—	49	51	—	—
1·26	97	178	—	—	19	4	—	—
1·33	39	63	—	—	—	1	—	—
1·41	15	6	—	—	—	—	—	—
1·48	9	—	—	—	—	—	—	—
1·55	3	—	—	—	—	—	—	—
1·63	—	—	—	—	—	—	—	—
1·70	—	—	—	—	—	—	—	—
1·78	—	—	2, 4 (6)	1, 1 (2)	—	—	—	—
1·85	—	—			—	—	—	—
1·92	—	—	3, — (3)	1, 2 (3)	—	—	—	—
2·00	—	—			—	—	—	—
2·07	—	—	4, 4 (8)	4, 2 (6)	—	—	—	—
2·15	—	—			—	—	—	—
2·22	—	—	19, 17 (36)	8, 6 (14)	—	—	—	—
2·29	—	—			—	—	—	—
2·37	—	—	24, 34 (58)	8, 11 (19)	—	—	—	—
2·44	—	—			—	—	—	—
2·52	—	—	41, 39 (80)	16, 18 (34)	—	—	—	—
2·59	—	—			—	—	—	—
2·66	—	—	46, 59 (105)	23, 23 (46)	—	—	—	—
2·74	—	—			—	—	—	—
2·81	—	—	64, 43 (107)	50, 34 (84)	—	—	—	—
2·89	—	—			—	—	—	—
2·96	—	—	58, 49 (107)	67, 68 (135)	—	—	—	—
3·03	—	—			—	—	—	—
3·11	—	—	45, 53 (98)	66, 46 (112)	—	—	—	—
3·18	—	—			—	—	—	—
3·26	—	—	34, 30 (64)	55, 30 (85)	—	—	—	—
3·33	—	—			—	—	—	—
3·40	—	—	23, 18 (41)	18, 20 (38)	—	—	—	—
3·48	—	—			—	—	—	—
3·55	—	—	17, 5 (22)	7, 2 (9)	—	—	—	—
3·63	—	—			—	—	—	—
3·70	—	—	3, 1 (4)	—, 1 (1)	—	—	—	—
3·77	—	—			—	—	—	—
3·85	—	—	1, — (1)	—	—	—	—	—
3·92	—	—		—	—	—	—	—

There appear to be traces of three peaks in the Rod B frequency curves in both years but they are not well marked and may be the result of a flat monomodal frequency. A similar effect would be obtained from two flat monomodal curves which overlap each other considerably. The overlapping portions when added together would give a central peak.

TABLE VI.

Frequencies of wing-ratios.

Wing-ratio	0·0	0·3	0·7	1·0	1·3	1·7	2·0	2·3	2·7	3·0	3·3
Freq. in 1935 .	0	3	25	24	60	128	130	120	97	32	39
Freq. in 1936 .	0	1	0	8	28	56	76	117	88	64	60

Wing-ratio	3·7	4·0	4·3	4·7	5·0	5·3	5·7	6·0	6·3	6·7	7·0
Freq. in 1935 .	19	14	4	1	1	0	1	0	0	0	1
Freq. in 1936 .	24	22	16	8	3	4	1	2	3	0	0

There were also one individual with a wing-ratio of 7·3 and two with ratios of 8·7 in 1935.

The histograms of the 1936 numbers are not so symmetrical as for the previous year. There was a tendency for the lower values of the characters to spread; see figs. 1 and 2.

(5) *Effect of Treatment of Larvae on Adult Structure.*

The investigations in 1936 showed the effect of certain factors on the adult structure. The characters measured were not independent of the treatment of the larvae and pupae. The time of collection of the larvae appeared to affect the adult size, and a variation in the adult structure due to variation in the time of emergence of the moths was also noted. These facts render less certain any deductions made from uncontrolled collections such as those of 1935.

(a) *Effect of varying the length of time larvae were kept in the laboratory.*

Larvae were collected on 22 June, before they had pupated, from three oak-trees near Wokingham, and 21 days later, on 13 July, a further collection was made, when the majority of the larvae had pupated. The two sets were termed Wokingham I and II. Wokingham I emerged over a period 14 July to 27 July with maximum during 22–26 July. Average date of emergence (*i.e.* $\frac{\text{Sum (number per date} \times \text{date)}}{\text{Total number over whole period}}$ 22.7. Wokingham II emerged over period 16 July–2 Aug. Average date of emergence 23·1. It will be seen that there was very little difference in the average emergence date of the two sets. There was a decided difference in the average sizes of the adults from the two collections. The averages for the characters studied are tabulated below. In this and the following tables the Standard Deviations for each average are given from

$$S^2 = \frac{\sum \overline{\overline{x} - x}^2}{n - 1}$$

i.e., the standard deviation of the population.

Each pair of averages was subjected to the test for significance of differences between means and the value of t in the equation given in Fisher (1934). Using Fisher's Table IV of t the significance of the differences can be estimated.

TABLE VII.

Comparison of the effect of collection date of the larvae on the mean character sizes of the adults.

	Head diam., mm.	Ant. seg-ments number	T.N.	Ovipositor rod length in mm.				Wing ratio
				A.	B.	C.	D.	
Wok. I . .	0·35	10·74	19·25	1·00	2·54	0·83	0·62	2·67
Stand. Dev. .	0·02	0·98	2·51	0·12	0·29	0·11	0·07	1·13
Wok. II . .	0·36	11·68	21·63	1·16	2·96	1·00	0·70	2·37
Stand. Dev. .	0·02	0·54	2·10	0·10	0·29	0·11	0·09	0·70
t . . .	3·2	7·5	6·5	9·7	9·1	9·7	6·5	*2·07*

Number of specimens in each set was 47. Hence in Fisher's table for significance tests $n = 92$. From this table $P = 0{\cdot}01$ when $t = 2{\cdot}576$ and $P = 0{\cdot}05$ when $t = 1{\cdot}96$, hence all the pairs of mean sizes above are significantly different by wide margins except the wing-ratio. In this and following tables values of t indicating non-significance are in italics.

The two sets of adults show an interesting variation in the numbers of individuals having tarsal numbers 24, 22, 20, and 18. The four groups occur in unequal numbers, but the set of larvae kept for a month in the laboratory before emergence of the adults produced a series having more individuals possessing low tarsal numbers.

TABLE VIII.

Effect of collection date on frequencies of tarsal number.

Tarsal number	18	20	22	24
Wokingham I Freq. . .	14	5	10	4
Wokingham II Freq. . .	8	5	16	13

The two sets of larvae and pupae were treated similarly. The cases were each enclosed in a gelatin capsule in which it remained until the moth emerged. The adults were preserved for examination in 70% alcohol. The only difference in treatment that the two sets received was the length of time each was kept in the laboratory.

(b) *Effect of variation in the emergence date of adults.*

Pupae were collected on 6 July from one locality in Slough. They commenced to emerge immediately. The adults were divided into three groups of 45 each according to the date on which they emerged. Group A emerged from 7 July to 9 July, group B from 10 July to 17 July, and the last group C from 18 July to 27 July. The average character-sizes for each period are tabulated below (Table IX).

It will be noted that there tends to be a drop in the size of the characters after the early period and that this difference is statistically significant except in the tarsal number and wing-ratio. Later in the emergence period the reduction in size is less; the differences here are not significant except wing-ratio, which for some reason shows a definite increase.

There seems to be a marked tendency for the average sizes of the adults to be smaller for collections having late emergence dates.

TABLE IX.

Comparison of the effect of variation of emergence date on the adult structure.

	Head diam., mm.	Ant. segments number	T.N.	Ovipositor rod length in mm.				Wing-ratio
				A.	B.	C.	D.	
Group A . .	0·38	11·9	22·9	1·27	3·22	1·12	0·75	2·90
Stand. Dev. .	0·02	0·44	1·33	0·07	0·22	0·08	0·07	0·71
Group B . .	0·37	11·3	22·2	1·21	3·00	1·07	0·69	2·5
Stand. Dev. .	0·01	0·66	1·55	0·07	0·20	0·06	0·04	0·61
Group C . .	0·37	11·6	21·2	1·20	2·99	1·03	0·69	3·2
Stand. Dev. .	0·02	0·65	2·35	0·06	0·17	0·06	0·04	0·92
(A × B) *t* . .	3·05	5·2	*2·32*	4·1	5·0	3·4	5·1	*2·06*
(B × C) *t* . .	*1·21*	*2·18*	*2·41*	*0·74*	*0·03*	3·2	*0·0*	4·3

Number of specimens in each group was 45. Hence $n = 88$ for each comparison. The values of t showing pairs to be not significantly different are in italics ($P = 0{\cdot}01$). If the limit $P = 0{\cdot}05$ be taken as the criterion, all the characters are significantly different in A and B and half of them in comparing B and C.

(c) *Effect of species of tree on which larvae have lived.*

As far as it was possible to determine, the species of tree upon which the larvae had been living had no effect on the adult characters.

(d) *Summary of the effect of treatment of larvae upon adult structure.*

The above results indicate that any investigation into the occurrence of local races in different parts of the range of the species must allow for changes in average size of adults from any locality, due to the treatment which they have received prior to emergence. When collections over a wide field are required, as in this study during 1935, in order to attempt to recognise local races of the species, it is extremely difficult to get them completed in a short enough time to be sure the treatment does not seriously affect the average sizes of the different colonies.

As it was not possible to repeat the first year's collecting in 1936, it was decided to attempt to distinguish certain races after allowing for the known effects of differing lengths of time in the laboratory.

These effects are caused by early collection of the larvae and subsequent pupation in the laboratory, resulting in a reduction of average size in the adults, and by using adults which emerged late in a given set from a locality. The latter would have a smaller size than those from the same set which emerged earlier.

(6) *Use of Ratios as racial Characters.*

Since the characters measured were partly correlated together, and also affected by the treatment of the insects, it was thought that ratios between some of the characters might be a better racial character. The ratios studied have been defined above on p. 157. They appear to be less affected by external conditions than are the direct measurements of the characters. The ratios observed for the Wokingham sets, and for the three groups of adults from Slough, having varying emergence periods, are tabulated below.

TABLE X.

Effect of collection date on character ratios.

	B/A	A/C	Head/Ant.	Head/T.N.	Ant./T.N.
Wokingham I . .	2·54	1·16	1·95	1·09	0·56
Wokingham II .	2·55	1·16	1·84	0·99	0·54

TABLE XI.

Effect of variation of emergence date on character ratios.

	B/A	A/C	Head/Ant.	Head/T.N.	Ant./T.N.
Group A . . .	2·54	1·15	1·88	0·98	0·52
Group B . . .	2·47	1·14	1·94	0·99	0·51
Group C . . .	2·50	1·16	1·90	1·04	0·55

(7) *Stability of the Character of Colonies from one Year to the next.*

There appeared to be some tendency for the sizes and ratios of the adults from one locality to resemble one another in two successive years. They at least tended to show the same relations to other colonies; see Table XII. The collections were made from the same few trees in 1936 as in 1935.

TABLE XII.

Comparison of pairs of localities in 1935 and 1936.

Bourne End / Theale	Head	Ant.	T.N.	A.	B.	C.	D.	Wing
1935 Ratios . .	1·087	1·027	1·142	1·166	1·150	1·173	1·141	1·166
1936 Ratios . .	1·027	1·053	0·967	1·107	1·073	1·088	1·000	1·104
N. Burnham / S. Burnham								
1935 Ratios . .	1·067	1·000	1·042	1·076	1·134	1·133	1·108	—
1936 Ratios . .	1·078	1·057	1·096	1·089	1·096	1·120	1·116	1·072

The average sizes of the characters for each locality in the two years are compared as ratios, *i.e.* average head-diameter for Bourne End divided by the average head-diameter for Theale in 1935 is compared with the same ratio for 1936.

In most of these comparisons the ratios are such that if the head ratio of one year is larger that that of the second year, the other character ratios show similar relationship. There is far less variation in this respect than is shown by the character size averages for the two years from the same localities. In this comparison the larvae used were collected off the same trees each year.

The table below gives these average sizes together with the values of t for comparison of the means. The values of t indicating a difference *not* significant are in italics. About 30% of the differences are not significant, indicating more variation than the ratios showed.

TABLE XIII.

Comparison of average size of structure in adults from four localities in 1935 and 1936.

	Head diam., mm.	Ant. segments number	T.N.	Ovipositor rod length in mm.				Wing-ratio	No. per set
				A.	B.	C.	D.		
Bourne End									
1935. . .	0·39	11·6	22·4	1·22	3·20	1·10	0·72	2·10	40
Stand. Dev. .	0·018	0·60	1·70	0·06	0·19	0·05	0·05	0·69	
1936. . .	0·366	10·35	17·25	1·16	2·83	0·98	0·67	2·44	45
Stand. Dev. .	0·015	1·15	3·10	0·09	0·25	0·07	0·04	1·19	
t . . .	7·46	6·25	9·4	3·63	7·73	9·2	5·23	*1·59*	
Theale									
1935. . .	0·36	11·3	19·60	1·04	2·73	0·94	0·63	1·80	50
Stand. Dev. .	0·021	1·21	2·23	0·09	0·37	0·09	0·07	0·69	
1936. . .	0·357	9·80	17·80	1·05	2·63	0·90	0·67	2·21	38
Stand. Dev. .	0·020	1·31	2·88	0·09	0·27	0·09	0·07	0·71	
t . . .	*0·69*	5·58	3·35	*0·52*	*1·41*	*2·07*	2·66	2·72	
N. Burnham									
1935. . .	0·406	11·4	22·5	1·35	3·50	1·22	0·76	—	9
Stand. Dev. .	0·010	0·52	—	0·09	0·14	0·08	0·09	—	
1936. . .	0·399	11·7	21·6	1·24	3·11	1·10	0·73	2·54	42
Stand. Dev. .	0·018	0·51	2·67	0·07	0·22	0·06	0·05	0·68	
t . . .	*0·37*	*1·59*	—	4·05	5·07	5·1	*1·41*	—	
S. Burnham									
1935. . .	0·381	11·4	21·6	1·25	3·08	1·08	0·69	—	13
Stand. Dev. .	0·018	0·49	—	0·11	0·23	0·06	0·05	—	
1936. . .	0·362	11·05	19·70	1·14	2·84	0·98	0·66	2·37	43
Stand. Dev. .	0·028	1·16	3·08	0·14	0·40	0·13	0·07	0·86	
t . . .	7·25	*1·05*	—	2·6	*2·05*	2·67	*1·43*	—	

It is possible that the characters measured are not inherited. Temperature and other climatic factors may have a larger effect on the detailed sizes of the characters than heredity. Definite breeding experiments would settle this matter, but the moth is difficult to rear from the egg.

The corresponding character-ratios for the four localities in the two years are given in Table XIV.

TABLE XIV.

Character-ratios for same localities in successive years.

		B/A	A/C	Head/Ant.	Head/Tar.	Ant./Tar.
Bourne End	1935	2·63	1·11	1·99	1·03	0·52
	1936	2·43	1·16	2·08	1·25	0·60
Theale	1935	2·61	1·13	1·96	1·08	0·58
	1936	2·50	1·16	2·13	1·18	0·55
N. Burnham	1935	2·59	1·10	2·10	1·06	0·51
	1936	2·52	1·12	1·96	1·06	0·54
S. Burnham	1935	2·46	1·16	1·96	1·04	0·53
	1936	2·50	1·16	1·93	1·08	0·56

The correspondence in the ratios in successive years appears to vary somewhat. On the whole, the ratios would appear to be better racial criteria than the actual linear measurements of the characters. The fact that the linear measurements show a correspondence in the two years while the ratios do not, may mean that each colony has a characteristic average size.

(8) *Differences between Colonies varying Distances apart.*

The variation exhibited by the species in one locality is less than that shown between localities more than a few miles apart. In Tables XV to XVII

TABLE XV.

Comparison of average sizes of adult characters from 2 pairs of trees at Slough, Bucks.

	Head diam., mm.	Ant. segments number	T.N.	Ovipositor rod length in mm.				Wing-ratio	No. per set
				A.	B.	C.	D.		
Tree (a) . .	0·389	11·66	22·80	1·24	3·17	1·07	0·72	2·75	50
Stand. Dev. .	0·017	0·52	1·55	0·07	0·18	0·06	0·05	0·88	
Tree (b) . .	0·393	11·65	23·00	1·24	3·17	1·09	0·70	3·15	43
Stand. Dev. .	0·013	0·48	1·13	0·06	0·19	0·04	0·04	1·42	
Tree (c) . .	0·388	11·78	22·90	1·22	3·13	1·08	0·73	2·76	49
Stand. Dev. .	0·014	0·47	1·59	0·07	0·21	0·07	0·06	0·97	
Tree (d) . .	0·392	11·82	23·30	1·22	3·06	1·07	0·72	2·94	50
Stand. Dev. .	0·014	0·44	1·07	0·07	0·19	0·06	0·05	1·10	
t (a *v.* b) . .	*1·25*	*0·09*	*0·69*	*0·0*	*0·0*	*1·85*	*1·72*	*1·65*	—
t (b *v.* c) . .	*1·76*	*1·31*	*0·35*	*1·45*	*0·95*	*0·82*	2·76	*1·55*	—
t (c *v.* d) . .	*1·42*	*0·44*	*1·49*	*0·0*	*1·74*	*0·76*	*0·91*	*1·06*	—
tt (a *v.* c) . .	*0·33*	*1·20*	*0·32*	*1·43*	*1·02*	*0·76*	*0·91*	*0·05*	—
t (a *v.* d) . .	*0·97*	*1·67*	*1·91*	*1·43*	2·97	*0·0*	*0·0*	*0·96*	—
t (b *v.* d) . .	*0·35*	*1·75*	*1·32*	*1·46*	2·78	*1·92*	2·4	*0·80*	—

are given the averages obtained for individuals from 2 pairs of different trees growing within a few yards of one another at Slough (Table XV), for individuals from two loci in Slough (Table XVI), and for four widely separated colonies (Table XVII).

Trees (a) and (b) were adjacent to each other and about 10 yards apart. They were about 25 yards away from the second pair (c) and (d), which were on the opposite side of the road to the first pair.

TABLE XVI.

Comparison of the average sizes of adult characters from two localities in Slough.

	Head diam., mm.	Ant. segments number	T.N.	Ovipositor rod length in mm.				Wing-ratio	No. per set
				A.	B.	C.	D.		
Loc. 1 . .	0·391	11·72	23·00	1·23	3·12	1·08	0·72	2·90	192
Stand. Dev. .	0·015	0·46	1·37	0·07	0·22	0·06	0·05	1·26	
Loc. 2 . .	0·376	11·59	22·10	1·23	3·07	1·07	0·70	2·85	135
Stand. Dev. .	0·017	0·63	1·93	0·07	0·26	0·07	0·06	0·84	
t . . .	*8·36*	*2·18*	4·92	*0·0*	*0·74*	*1·39*	3·27	*0·4*	—

In both Table XV and Table XVI the pupated cases were in the laboratory about 4 days before the adults began to emerge.

The adults used for Table XVII received the following treatment; the first pair of localities were represented by a collection of larvae which were kept in

TABLE XVII.

Comparison of the average sizes of adult characters from localities several miles apart.

	Head diam., mm.	Ant. segments number	T.N.	Ovipositor rod length in mm.				Wing-ratio	No. per set
				A.	B.	C.	D.		
Bourne End .	0·366	10·35	17·25	1·16	2·83	0·98	0·67	2·44	45
Stand. Dev. .	0·015	1·15	3·10	0·09	0·25	0·07	0·04	1·19	
Theale . .	0·357	9·80	17·80	1·05	2·63	0·90	0·67	2·21	38
Stand. Dev. .	0·020	1·31	2·88	0·09	0·27	0·09	0·07	0·71	
Wokingham II .	0·365	11·68	21·60	1·16	2·96	1·00	0·70	2·37	47
Stand. Dev. .	0·023	0·54	2·10	0·10	0·29	0·11	0·09	0·70	
Slough I . .	0·391	11·72	23·00	1·24	3·02	1·08	0·72	2·90	192
Stand. Dev. .	0·015	0·46	1·37	0·07	0·22	0·06	0·05	1·26	
t (BE *v.* T) .	*2·33*	*2·03*	*0·83*	5·53	3·56	4·6	*0·0*	*1·05*	—
t (T *v.* W) .	*1·72*	8·99	7·08	5·25	5·53	4·53	*1·69*	*1·05*	—
tt (W *v.* S) .	9·45	*0·51*	5·59	6·14	*1·57*	6·55	*2·06*	2·78	—
t (BE *v.* W) .	*0·25*	7·51	8·2	*0·0*	*2·31*	*1·07*	*2·21*	*0·36*	—
t (BE *v.* S) .	10·1	12·7	19·3	6·43	4·98	9·6	6·03	2·27	—
t (T *v.* S) . .	11·9	19·7	17·2	15·3	9·6	14·5	5·12	3·63	—

the laboratory for about 30 days before the adults emerged. The collection from the second pair of localities were not kept in the laboratory so long, fewer than 10 days before the majority of the adults had emerged.

The variation of the adults from localities varying distances apart is summarised in the following table. The percentage of significant differences between pairs of characters in collections from different localities indicates the

TABLE XVIII.

Effect of collecting from localities varying distances apart.

	No. of pairs compared	No. signif. difference	% no. signif. difference	Av. dist. apart
Four localities from adjacent trees	48	4	8·3	20 yards
Two localities in Slough . .	8	3	38	½ mile
Four localities some miles apart .	48	31	64	8 miles

amount of variation between these localities. The variation appears to increase rapidly at first and then more slowly, as the localities are farther apart.

The ratios for the same localities are given in Table XIX.

TABLE XIX.

Character-ratios from varying localities.

	B/A	A/C	Head/Ant.	Head/T.N.	Ant./T.N.
Tree (a) . . .	2·56	1·16	1·98	1·00	0·51
Tree (b) . . .	2·56	1·14	1·98	1·00	0·51
Tree (c) . . .	2·56	1·13	1·95	0·99	0·51
Tree (d) . . .	2·51	1·14	1·97	0·99	0·51
Slough Loc. 1 . .	2·54	1·14	1·97	1·00	0·51
Slough Loc. 2 . .	2·50	1·15	1·90	1·00	0·52
Bourne End . .	2·43	1·16	2·08	1·25	0·60
Theale . . .	2·50	1·16	2·13	1·18	0·55
Wokingham II .	2·55	1·16	1·84	0·99	0·54
Slough Loc. 1 . .	2·44	1·14	1·97	1·00	0·51

The ratios are less variable and they show the effect of distance in varying degrees. B/A and A/C do not exhibit much difference in the different localities. The last three ratios do, however, appear to vary more in widely separated localities than in adjacent ones.

(9) *Resemblance of very distant Colonies to one another.*

No colonies have been found which resemble one another in all characters. There have been examples, however, where two widely separated localities have similar average characters, sometimes one or two. The averages for head-diameter appear to fall roughly into two classes (see below (10)). The smaller sizes of head were observed from such widely spread localities as Battle in Sussex, Hungerford in Berkshire, and Trimley in Suffolk; while the larger size occurred

equally widely spread from Horsham in Sussex to Wantage in Berkshire, and Epping in Essex.

These two head-diameter classes showed considerable variation in themselves, so that no two colonies from two localities far away from each other could be really described as being similar to one another.

(10) *Geographical Distribution of Characters.*

An attempt was made to associate the characters with the geographical position of the colony. The evidence for the existence of races in *L. ferchaultella* put forward by Tutt and Chapman was based on too few localities and, what is more important, on too few individuals.

There are distinct differences in the average sizes of the adult characters from different localities. They do not appear to be easily arranged geographically, though one or two grouped localities appear to exhibit similar average structures. The most obvious example of this is that shown by two localities in Essex. The averages obtained for these localities were less than those holding in other localities. The head-diameter appeared to be of the smaller of the two main types, while the other characters were considerably smaller than those from any other locality studied. This was possibly due to keeping the larvae in the laboratory before pupation, but even allowing for this effect, the adults were distinctly smaller than normal. The ratios for these localities showed, however, that there was no real difference except in size between these forms and the specimens obtained over the other parts of the range. There is a possibility that the differences in sizes are due to a temperature–time effect, the eastern localities having a distinctly colder winter and spring than do the more westerly ones.

The approximate averages for the Essex localities were :—

Head, mm.	Ant.	T.N.	A, mm.	B, mm.	C, mm.	D, mm.	Wing
0·35	10	17	1·0	2·5	0·9	0·65	Over 2·4

Several other less distinctive groups were detected in the southern part of the range of the species. There was one covering most of Surrey and Sussex having adults tending to have the approximate average structure :—

Head, mm.	Ant.	T.N.	A, mm.	B, mm.	C, mm.	D, mm.	Wing
0·38	11·5–12	22·0	1·2	3·1	1·03	0·74	About 2·4

The above type resembles averages of colonies from Horsham, Petworth, Guildford and Oxshott and the more northerly localities from Oxfordshire, Buckinghamshire and Essex : Wantage, Wallingford, Bourne End, Burnham Beeches, Epping, Barnet and Orsett.

A still smaller type with the small-size head occurred in a group of localities in Sussex, Hampshire, Berkshire and Oxon—Battle, Steyning, Wokingham, Theale, Hungerford and Abingdon. This type has average sizes approximating to the following :—

Head, mm.	Ant.	T.N.	A, mm.	B, mm.	C, mm.	D, mm.	Wing
0·35	10–11·5	20·0	1·07	2·8	0·96	0·74	Less 2·3

The averages from Battle show a larger value for Ant. and T.N. A collection from Rickmansworth appears to be intermediate between this and the smaller Essex group. This may be an effect of position on the Chiltern Dip-Slope, up which the species gradually dies out. Apart from this, there do not appear to be intermediate types joining these three size groups, which are of course based upon averages for the localities. Though the differences between them are small, the measurements were sensitive enough to have detected smaller differences. The three types, where they differ, do so significantly from each other. Comparisons of the average sizes between localities within one of these groups have been made as well as comparisons between localities in different groups. Using the same method of comparison as in Table XXIV, it was found that the percentage variations within the groups and between them were :—Group I, Essex, 37·5% of differences were significant. Group II, Horsham, Epping etc. 14% significantly different. Group III, Battle, Theale etc. 22% significantly different. Comparisons between Groups I and II localities were 100% significantly different. Similarly between Groups I and III. Comparisons between localities in Groups II and III gave much greater numbers of different averages than were obtained within one or the other group. All the possible comparisons were not made, but sufficient were worked out to make it certain that the three groups should be regarded as fairly distinct ones.

There is some evidence indicating that moths collected from trees on hills, and up valleys near to the natural limits of distribution of the species, have a characteristically smaller size than occurs in localities adjacent at lower altitudes. This was observed for Rickmansworth, where the moths were decidedly smaller than from the other localities within short distances down the valley, *i.e.* Iver, Burnham. Rickmansworth is rather high up in the Chiltern Hills in a valley up which the moth appears to have difficulty in migrating (McDonogh 1939).

It seems probable that the population of this species in England consists of more or less a mixture of at least two (based upon head-diameter) or even three size types or groups. If other characters are considered collectively, as well as the head-diameter, the three groups are fairly distinct. Different localities appear to have the types present in varying proportions. Further evidence of these types is considered and supported by the study of the tarsal number (see (11) below).

The lack of really distinct local races, of the type described by Tutt and Chapman, is probably due to the fact that the rate of migration of the species is much greater than appeared probable *a priori*. The wind-migration appears to act fairly rapidly (McDonogh 1939).

There appears to be a difference in larval head-diameter in corresponding instars between different localities. Epping and Richmond were studied in this respect, but the problem of larval races is not dealt with in the present paper.

(11) *Study of Variation in Tarsal Number.*

The tarsal formulae of the adults show considerable variation. This is studied more fully below. It is, however, necessary to mention here that there are certain stable formulae which have occurred more frequently than the others. These are indicated in the frequency histograms, fig. 1. The largest group was the 3–4–4, the 4–4–4 type being the next largest. In 1935 only 64 of the specimens bred had asymmetrical formulae. In a number of individuals

the last tarsal segment was almost fused with the penultimate segment. These were noted by italicising the number, so that *4* means a leg actually with a fourth segment but appearing to have three segments. The numbers of each type observed in the 1935 collection were :—

4–4–4 . . . 123	3–4–3 . . . 18	2–3–3 . . . 59
4–4–4 . . . 26	3–3–4 . . . 58	2–2–3 . . . 4
3–4–4 . . . 143	3–3–3 . . . 115	2–2–2 . . . 9

The remaining 64 specimens had asymmetrical or odd arrangements of segments. The majority of these types had only one or two individuals, except

3–3–3 . . . 4	2–3–4 . . . 3
3–*4*–4 . . . 9	2–3–2 . . . 4
3–*4*–3 . . . 4	3–3–*3* . . . 4

The really asymmetrical types had different arrangements on the two sides.

As the tarsal number is bimodal, it was given special study. The character sizes for the four largest tarsal number groups in each year were averaged. In this only the measurements of the symmetrical groups 24, 22, 20 and 18 tarsal segments were used. The average size figures obtained are given in Table XX.

TABLE XX.

Comparison of average sizes of adult characters of different tarsal number groups, 1935.

	Head diam., mm.	Ant. segments number	Ovipositor rod length in mm.				Wing-ratio	No. per set
			A.	B.	C.	D.		
T.N. 18 . .	0·343	10·80	1·04	2·67	0·92	0·65	2·10	119
Stand. Dev. .	0·021	1·08	0·12	0·29	0·10	0·08	0·80	
T.N. 20 . .	0·358	10·70	1·09	2·80	0·96	0·67	2·30	77
Stand. Dev. .	0·026	1·04	0·12	0·34	0·11	0·07	0·89	
T.N. 22 . .	0·362	11·45	1·12	2·94	1·01	0·68	2·10	150
Stand. Dev. .	0·022	0·89	0·11	0·30	0·10	0·07	0·69	
T.N. 24 . .	0·384	11·85	1·22	3·17	1·09	0·72	2·30	124
Stand. Dev. .	0·023	0·63	0·12	0·26	0·10	0·07	0·79	
t (18–20) . .	4·26	*0·64*	2·96	2·49	2·63	*1·98*	*2·19*	—
t (22–20) . .	*1·22*	5·7	*1·94*	4·76	2·9	*1·02*	*1·88*	—
t (24–22) . .	8·06	4·02	7·18	6·49	6·59	4·8	*2·25*	—

It will be noted in the figures for 1935 that the averages for the groups 20 and 22 are closer to each other than they are to their neighbouring group (see table of differences for that year). If group 20 is ignored and the difference between 22 and 18 compared with that of 24–22 it will be seen that the group 22 is approximately intermediate in size between groups 18 and 24 (Table XXI).

On studying the frequency diagrams for the characters in each tarsal group for 1935, it was found that the diagrams were apparently bimodal for tarsal number 20. This suggests that actually group 20 is a mixture, partly type 18 T.N. and partly type 22 T.N. (see figs. 3–6).

The 20 T.N. group was inspected to see if it could be easily sub-divided.

There are two types of tarsal formula present in the group, 3–3–4 and 3–4–3. These two types were separated. There were 57 individuals with the former formula and 16 with the latter. In both groups there was evidence of bimodal frequency, hence the form of the tarsal formula does not appear to affect the type size. The head-diameter of the 3–3–4 type was apparently monomodal

TABLE XXI.

Differences of averages for different T.N.

1935	Head, mm.	Ant.	A, mm.	B, mm.	C, mm.	D, mm.	Wing
22–18 . . .	0·019	0·65	0·082	0·274	0·082	0·030	0·0
24–22 . . .	0·022	0·40	0·096	0·221	0·080	0·037	0·2

and about 0·354 mm. The head-diameter of the 3–4–3 type was definitely bimodal, having the averages of 0·354 and 0·391 mm. Ovipositor rod B was bimodal in type 3–4–3 and might almost have had three peaks in the 3–3–4 set. The wing-ratio was bimodal, with peaks at 1·7 and 2·7, in set 3–3–4. It was not so in the other set, where the maximum appeared to be about 2·0. The two sizes of rod B observed were 2·66-mm. and 3·03-mm. average length; these sizes more or less agree with the average length of these rods in groups 18 T.N. and 22 T.N. The two head-sizes also correspond fairly well with those of these two groups (see Table XXII).

In Table XXII the structure sizes for group 20 T.N. are divided into the two sub-groups which resemble the 18 T.N. and 22 T.N. groups. These average sizes were obtained from the 20 T.N. character frequencies by calculating the means of the two observed maxima, on the assumption that each was caused by a normally distributed frequency. They are referred to as " 18 " and " 22."

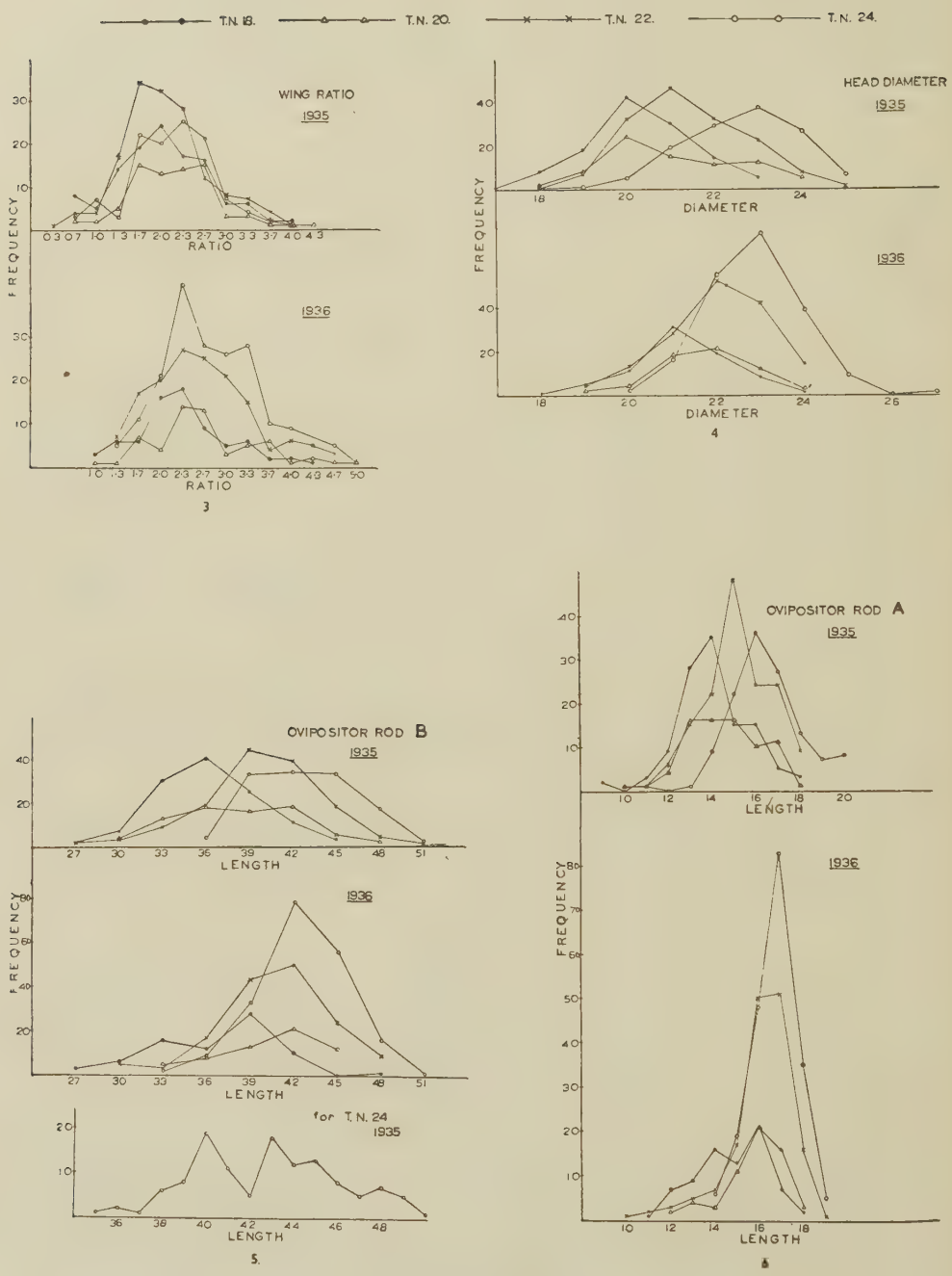
The monomodal wing-ratio (average value 2·0) for the 3–4–3 individuals resembles the wing-ratio averages for 22 T.N. and 18 T.N. better than do the ratio averages of " 18 " and " 22."

TABLE XXII.

	Head	A.	B.	C.	Wing	
T.N. 20 " 18 " .	0·354	0·96	2·66	0·89	1·7	2·0 (3–4–3 set)
" 22 " .	0·391	1·11	3·03	1·04	2·7	
T.N. 18 . . .	0·343	1·04	2·67	0·93	2·1	
T.N. 22 . . .	0·362	1·13	2·95	1·01	2·1	

Except for the head-diameter of T.N. " 22 " and T.N. 22, the agreement is fairly good.

In 1936 the frequency diagrams indicated that if any of the four groups were bimodal it was the 18 T.N. set. In this year the differences between 22–18 and 24–22 are not similar as in the previous year, though the 22–20 differences are small again. It is possible that if the average size of the species as a whole has become smaller, the group of the last year, which had 20 T.N. and was bimodal, may now have a tarsal number of 18, and this group would



FIGS. 3–6.—Frequency diagrams of different tarsal number groups.

(3) Wing-ratio, (4) Head-diameter, (5) Ovipositor rod B, (6) Ovipositor rod A.

now show the bimodal character. The averages for the two years, reckoned on the individuals from the same localities in both years, are given below, and are based upon sets of adults obtained from the same localities in both years :— Wokingham, Theale, Bourne End and Burnham Beeches.

TABLE XXIII.

Comparison of average sizes of adult characters of different tarsal number groups, 1936.

	Head diam., mm.	Ant. segments number	Ovipositor rod length in mm.				Wing-ratio	No. per set
			A.	B.	C.	D.		
T.N. 18 . .	0·360	10·70	1·09	2·71	0·94	0·65	2·45	76
Stand. Dev. .	0·019	0·96	0·12	0·30	0·11	0·06	0·92	
T.N. 20 . .	0·371	11·30	1·16	2·95	0·99	0·68	2·80	60
Stand. Dev. .	0·019	0·86	0·10	0·27	0·11	0·06	0·93	
T.N. 22 . .	0·374	11·50	1·19	2·99	1·04	0·68	2·70	153
Stand. Dev. .	0·021	0·96	0·11	0·31	0·11	0·07	0·86	
T.N. 24 . .	0·388	11·80	1·24	3·12	1·08	0·72	2·90	197
Stand. Dev. .	0·018	0·43	0·08	0·22	0·07	0·06	0·98	
t (18–20) . .	3·35	3·77	3·62	4·91	2·68	2·89	*2·19*	
t (22–20) . .	*0·98*	*1·41*	*1·57*	*0·81*	2·68	*0·0*	*0·75*	
t (24–22) . .	6·7	3·91	4·43	4·48	4·55	6·04	*1·99*	

The tarsal number is seen to be appreciably smaller in 1936. Also all the other characters exhibit a reduction in average size which is not, however, proportional in all of them. It is therefore possible that the change over to a bimodal T.N. 18 in place of T.N. 20 in the second year is a result of the general

TABLE XXIV.

Comparison of average sizes of adult characters in the two years 1935 and 1936.

	Head diam., mm.	Ant. segments number	T.N.	Ovipositor rod length in mm.				Wing-ratio	No. per set
				A.	B.	C.	D.		
1935 set . .	0·371	11·50	21·60	1·14	2·92	1·01	0·67	2·05	154
Stand. Dev. .	0·021	0·86	2·12	0·10	0·29	0·09	0·07	0·69	
1936 set . .	0·367	10·90	19·54	1·12	2·82	0·97	0·67	2·44	262
Stand. Dev. .	0·020	0·94	2·72	0·10	0·29	0·10	0·07	0·88	
t . . .	*1·97*	6·49	8·07	*1·97*	3·4	4·09	*0·0*	4·71	

reduction in size. (The year 1935–6 was several degrees cooler on the average than the preceding year.)

On inspection of the set T.N. 18, it was found that the head-diameter was not bimodal and its average size is given in Table XXIII. The antennal number was also not capable of being divided, though from the frequencies it

was very probably bimodal. The ovipositor rods, however, gave two types, the sizes of which are given in Table XXV. The wing-ratio could not be divided. It will be noted that the smaller of the two types in the 1936 T.N. 18 more nearly represents the correct sizes for that formula compared with those of T.N. 22 and T.N. 24, while the larger is similar to T.N. 22.

TABLE XXV.

	Head	A.	B.	C.	Wing
T.N. 18 "18" . .	0·360	1·04	2·44	0·89	2·45
"*22*" . .	—	*1·18*	*2·89*	*1·04*	—
T.N. 20	*0·371*	*1·16*	*2·95*	*0·99*	*2·8*
T.N. 22	*0·374*	*1·19*	*2·99*	*1·04*	*2·7*
T.N. 24	0·388	1·24	3·12	1·08	2·9

It appears as though there were still three main types as in 1935, but they cannot be so easily separated on the basis of tarsal number. The only " pure " group being T.N. 24. T.N. 22, 20 and part of 18 form the middle group (in italics in Table XXV) and part of T.N. 18 the last one.

Even the so-called " pure " group has shown a complex character. Fig. 5 is a frequency diagram of the ovipositor rod B for T.N. 24, 1935. It shows distinct traces of three peaks. It is, however, possible that this is due to the presence of two true peaks, the centre one being formed by the addition of the overlap of each true peak together to form a false peak. In 1936 the same rod showed a similar frequency curve though the maxima were not so distinct. In both years, too, the wing-ratio frequencies for T.N. 24 show signs of being bimodal (see fig. 3).

The ratios of the four tarsal types tend to be either fairly stable, *e.g.* A/B, A/C, and Head/Ant., or become smaller as the tarsal number increases. The

TABLE XXVI.

1935	B/A	A/C	Head/Ant.	Head/T.N.	Ant./T.N.
T.N. 18 . . .	2·57	1·12	1·87	1·12	0·60
T.N. 20 . . .	2·55	1·13	1·97	1·05	0·53
T.N. 22 . . .	2·62	1·12	1·86	0·97	0·52
T.N. 24 . . .	2·60	1·12	1·91	0·94	0·49
1936					
T.N. 18 . . .	2·47	1·16	1·98	1·18	0·59
T.N. 20 . . .	2·54	1·18	1·93	1·09	0·56
T.N. 22 . . .	2·51	1·15	1·92	1·00	0·52
T.N. 24 . . .	2·52	1·14	1·94	0·95	0·49

latter result is to be expected, since the head-diameter and the antennal number do not increase so rapidly as the tarsal number. The ratios appear to be much more constant than the size-characters, except for the two ratios mentioned above. The ratios for the two years are given in Table XXVI.

The ratios in both years indicate by their constancy that the types distinguished by linear measurements can scarcely be regarded even as varieties of the species.

(12) *Limits of Variation in* L. ferchaultella.

The following tables give the limits of the variation in the species.

TABLE XXVII.

Character	Total range	Range over which more than 12 individuals were found
Head-diameter	0·289 to 0·425 mm.	0·306 to 0·408 mm.
Antennal number	4 to 14	8 to 12
Tarsal number	12 to 24	16 to 24
Ovip. rod A	0·592 to 1·554 mm.	0·888 to 1·406 mm.
B	1·776 to 3·848 mm.	2·120 to 3·552 mm.
C	0·444 to 1·406 mm.	0·740 to 1·258 mm.
D	0·370 to 0·962 mm.	0·518 to 0·888 mm.
Wing-ratio	0·3 to 7·0	0·7 to 3·7

From any one locality the *range* was approximately the *average* for that place ± the following figures added to and subtracted from this average character size.

TABLE XXVIII.

Head-diameter, mm.	Ant. N.	Tarsal N.	A, mm.	B, mm.	C, mm.	D, mm.	Wing
0·0374	1·3	3·0	1·110	0·518	1·850	1·110	1·0

The averages in Table XXVIII show the extremes of the averages of each character in all the localities. Each figure represents the average of some character in a particular locality. The averages of all the other localities fell between the extremes given below.

TABLE XXIX.

Character	Head, mm.	Ant.	T.N.	A.	B.	C.	D.	Wing
Least average	0·338	9·42	16·6	0·977	2·479	0·873	0·614	1·7
Greatest average	0·413	12·09	22·6	1·347	3·493	1·225	0·762	2·8
Greatest/Least	1·22	1·28	1·36	1·38	1·40	1·40	1·24	1·65

The variation of the ratios of the characters in all the localities put together are given in Table XXX.

TABLE XXX.

B/A	A/C	Head/Ant.	Head/Tar. N.	Ant./Tarsal N.
2·38 to 2·73	1·07 to 1·22	1·68 to 2·26	0·90 to 1·20	0·47 to 0·62

(13) *Conclusions.*

No definite local variation of the sort postulated by Chapman has been detected, though there are signs that three main size-types may occur. They could not be definitely placed geographically. There was, however, evidence to show that with further investigation the three types might be fairly well located. The East Anglian form appears to be quite well defined. The two main types found in south and south-east England probably mix considerably in the area Hampshire and Berkshire. Further measurements of adults from the western part of the range of the species would be of interest, as also from the counties north and east of the Cotswolds.

The only important difference between the colonies is in size, and this affects all the other characters. This is affected also by the treatment of the larvae, probably by variations in seasonal climate, and possibly by geographical variations in climate, so that careful study is needed before ascribing colonial differences to inherited differences. Probably the species migrates much more rapidly than had been supposed, so that the colonies are always contaminating one another.

(14) References.

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